DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-290

TO 31R2-2GRC-101

FIELD MAINTENANCE

# RECEIVER-TRANSMITTERS RT-70/GRC AND RT-70A/GRC

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# RECEIVER TRANSMITTERS RT-70/GRC AND RT-70A/GRC


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*This manual supersedes TM 11-290, 4 April 1951 including C 1, 28 June 1952 and C 2, 5 November 1953.

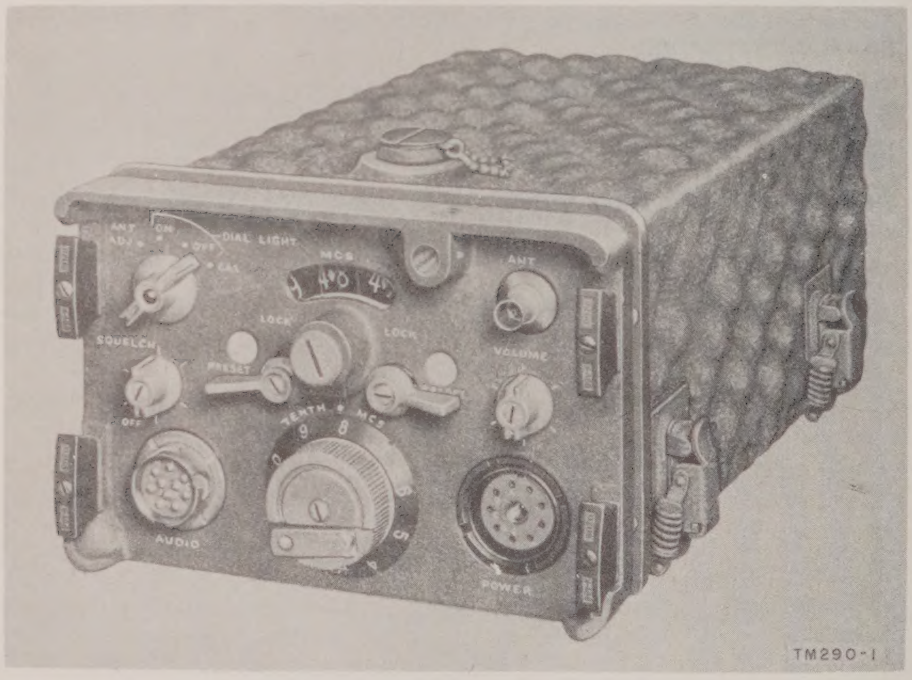



*Figure 1. Receiver-Transmitter RT–70(*)/GRC, overall view.*

# CHAPTER 1

# INTRODUCTION

## Section I. GENERAL

### 1. Scope

*a.* This manual contains a description, detailed theory of operation, and instructions for field maintenance and repair of Receiver-Transmitters RT–70/GRC and RT–70A/GRC (fig. 1). In addition, a chapter on the disassembly and the repacking of the equipment for shipment or limited storage is included. Instructions for installation, operation, and organizational maintenance of this equipment are contained in TM 11–284, Radio Sets AN/GRC–3, –4, –5, –6, –7, and –8.

*b.* Official nomenclature followed by (*) is used to indicate all models of the equipment covered in this manual. Thus, Receiver-Transmitter RT–70(*)/GRC represents both Receiver-Transmitter RT–70/GRC and Receiver-Transmitter RT-70A/GRC, and Handset H–33(*)/PT represents Handset H–33A/PT, Handset H–33B/PT, Handset H–33C/PT, Handset H–33D/PT and Handset H–33E/PT.

### 2. Forms and Records

*a. Unsatisfactory Equipment Reports.* Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to Commanding Officer, Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700–38.

*b. Damaged or Improper Shipment.* Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58.

## Section II. DESCRIPTION AND DATA

### 3. Purpose

*a.* Receiver-Transmitter RT–70(*)/GRC (fig. 1) is a small, lightweight radio set, less power supply and accessory equipments, designed for use in portable, ground, or vehicular installations. When suitably powered, the set provides two-way, push-to-talk, frequency-modulated (FM) communication with similar portable, ground, or mobile equipments over a 1-mile range.

*b.* The frequency coverage of Receiver-Transmitter RT-70(*)/GRC is indicated in the frequency spectrum chart (fig. 2). For comparison, the frequency coverage of other radio equipments with which it may be used, is given in the chart. For example, the chart shows that a considerable overlap exists between Receiver-Transmitter RT–68/GRC and Receiver-Transmitter RT–70(*)/GRC. Receiver-Transmitter RT–70(*)/GRC provides continuous tuning throughout the frequency range of 47 to 58.4 megacycles (mc).

### 4. System Application

*a.* Receiver-Transmitter RT–70(*)/GRC may be used as a component of a portable field set such as Radio Set AN/PRC–16 (fig. 3), as part of a vehicular installation such as Radio Set AN/VRC–7 (fig. 4), or as part of systems such as Radio Sets AN/GRC–3 through –8. The normal range of the receiver-transmitter is about 1 mile. Under favorable conditions of terrain, this range may be increased.

*b.* To use Receiver-Transmitter RT–70(*)/GRC in an operating installation, it is necessary to provide a suitable source of power (listed below). In addition, control, audio, and output connections must be provided along with an antenna assembly. The microphone input and the receiver audio output circuits are brought out to connectors on the front panel. Since these connections may be made to any audio equipment having the proper impedance and power handling capacity, a high degree of flexibility exists. For example, the audio circuits may be completed by direct connection to the front panel or extended through an amplifier (AF Amplifier AM–65/GRC) and a mounting (Mounting MT–300/GR) to a microphone and headset, a microphone and loudspeaker, or to a telephone line. The power circuits are also brought out to a connector on the front panel, making it possible to connect the set to any power source capable of providing 90 volts for the plates and screens of the tubes, and 6.3

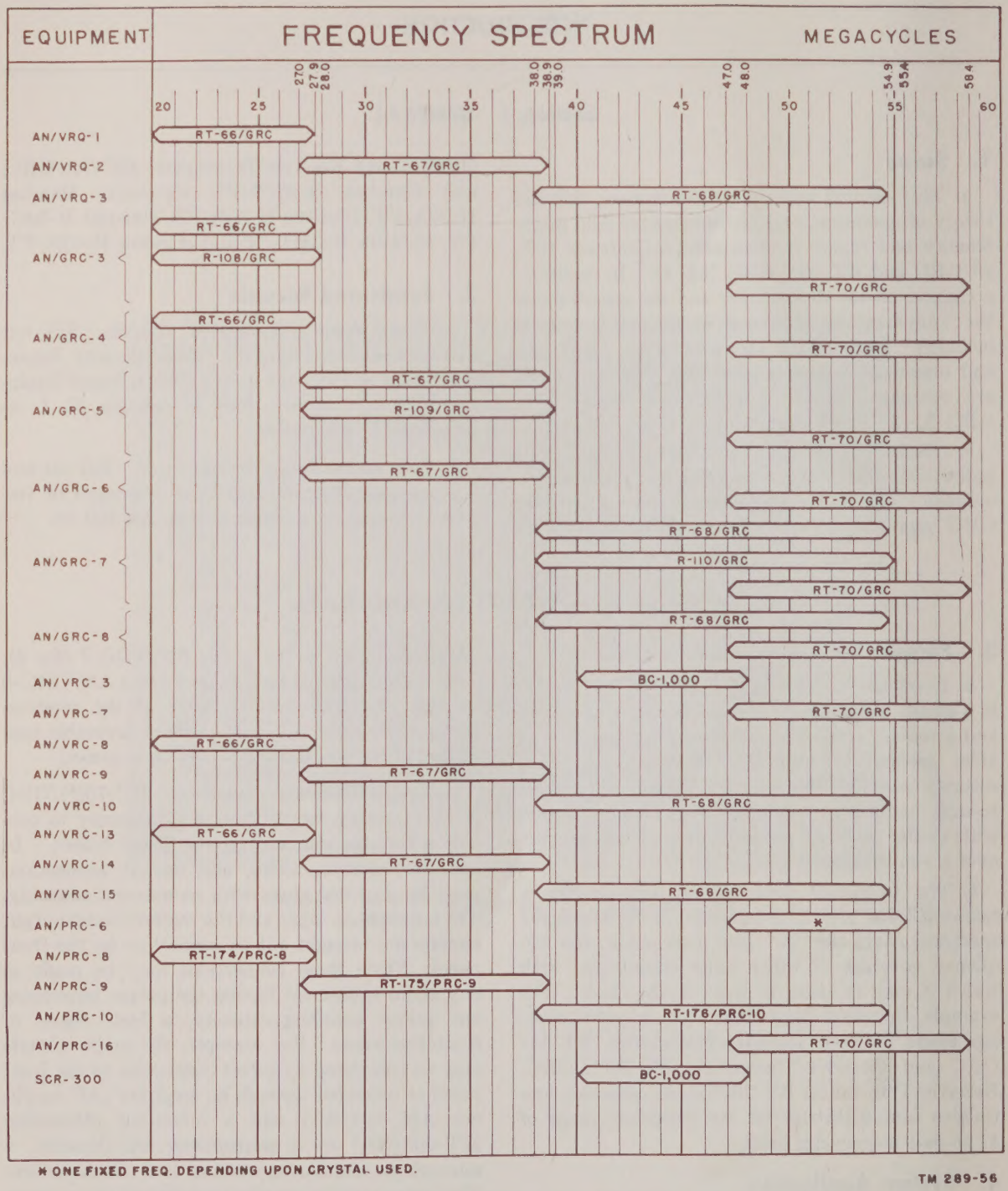



*Figure 2. Frequency spectrum chart.*

volts for the filaments, microphone, and the control relay. The power source may be a set of dry batteries (housed in Case CY–590/GRC) or a vibrator type power supply unit (Power Supply PP–448/GR, PP–281/GRC, or PP–282/GRC) housed in AF Amplifier AM–65/GRC and operating from the vehicular storage battery (6, 12, or 24 volts, respectively). Typical working installations are described briefly in *c* through *e* below.

*c.* Figure 3 shows the manner in which Receiver-Transmitter RT–70(*)/GRC is associated with the other components necessary to complete a portable field installation, such as Radio Set AN/PRC–16.

(1) The additional components necessary to complete Radio Set AN/PRC–16 include a set of dry batteries (90 volts and 7.5 volts) housed in a battery box, Case CY–590/GRC, a microphone with push-to-talk switch, a headset (both audio accessories must be equipped with 10-pin Connector U–77/U), an antenna, and a mounting plate. Power Cable Assembly CX–1209/U joins the control and power input circuits of the receiver-transmitter to the wiring and batteries in Case CY–590/GRC.

(2) A microphone switch, and a control relay within the receiver-transmitter control, reception and transmission. A sidetone circuit routes a portion of the microphone audio energy to the audio circuits of the receiver for monitoring purposes.

*d.* The combination of Receiver-Transmitter RT–70(*)/GRC, AF Amplifier AM–65/GRC, Control Box C–375/VRC, Power Supply PP–448/GR, PP–281/GRC, or PP–282/GRC, and suitable mountings, cables, audio accessories, and other installation components may be used in the radio installation known as Radio Set AN/VRC–7. Figure 4 is a functional block diagram of this set. In this arrangement, the amplifier provides for monitoring the receiver output of Receiver-Transmitter RT–70(*)/GRC, and interphone channel between control stations, monitoring of the interphone channel, and all operating potentials for its own circuits and for those of the receiver-transmitter.

*Note.* The amplifier portion of AF Amplifier AM–65/GRC provides three input and three output circuits. One of the input circuits is for connection to the receiver output of one receiver-transmitter (Receiver-Transmitter RT–70(*)/GRC or set 2), another is for connection to the interphone or control station microphones, and the third is for connection to the receiver output of another receiver-transmitter (set 1). Set 1 (either Receiver-Transmitter RT–66/GRC, RT–67/GRC, or RT–68/GRC) is not used in Radio Set AN/VRC–7. One of the three output circuits carries the amplified speech signals from set 2 and from the microphones (set 2 + interphone output), the other speech signals from set 1 and from the microphones, and the third signals from both receivers and from the microphones (set 1 + set 2 + interphone output). A mixing circuit within the amplifier makes this path arrangement possible.

*e.* The combination of Receiver-Transmitter RT–70(*)/GRC and AF Amplifier AM–65/GRC may be used in conjunction with a longer range receiver-transmitter and possibly an auxiliary receiver in any one of the more complex system installations, Radio Sets AN/GRC–3 through –8.

*f.* The major components which are normally associated with Receiver-Transmitter RT–70(*)/GRC are described in separate manuals. The manner in which Receiver-Transmitter RT–70(*)/GRC is used as part of a complete installation in a communication network is described in the technical manual for the particular radio set.

## 5. Technical Characteristics

*a. Overall Equipment.*

| | |
|---|---|
| Frequency range | 47 to 58.4 mc |
| Type of signals transmitted and received. | Fm voice |
| Type of tuning | Continuous |
| Number of present detented channels. | 2 |
| Channel spacing | 100 kc |
| Number of channels | 115 |
| Reliable communication range. | 1 mile |
| Type of operation | Push-to-talk |
| Type of control | Local or remote |
| Power requirements | 90 volts at 80 ma for plates and screens.<br>6.3 volts at 360 ma for filaments.<br>6.3 volts at 160 ma for relay (transmit only).<br>The above voltages obtainable either from dry batteries in Case CY–590/GRC or from vibrator type Power Supply PP–448/GR, Power Supply PP–281/GRC, or Power Supply PP–282/GRC and 6-, 12-, or 24-volt storage battery, respectively, through AF Amplifier AM–65/GRC. |
| Antenna requirements | Common whip type antenna 50-ohm impedance. |

*b. Transmitter Circuit.*

| | |
|---|---|
| Power output | 500 mw. |
| Maximum modulation frequency deviation. | ±20 kc at 1,000 cps with .25-volt input. |
| Frequency range | Continuously variable 47 to 58.4 mc. |
| Type of operational control | Push-to-talk transmitter normally in standby condition. |

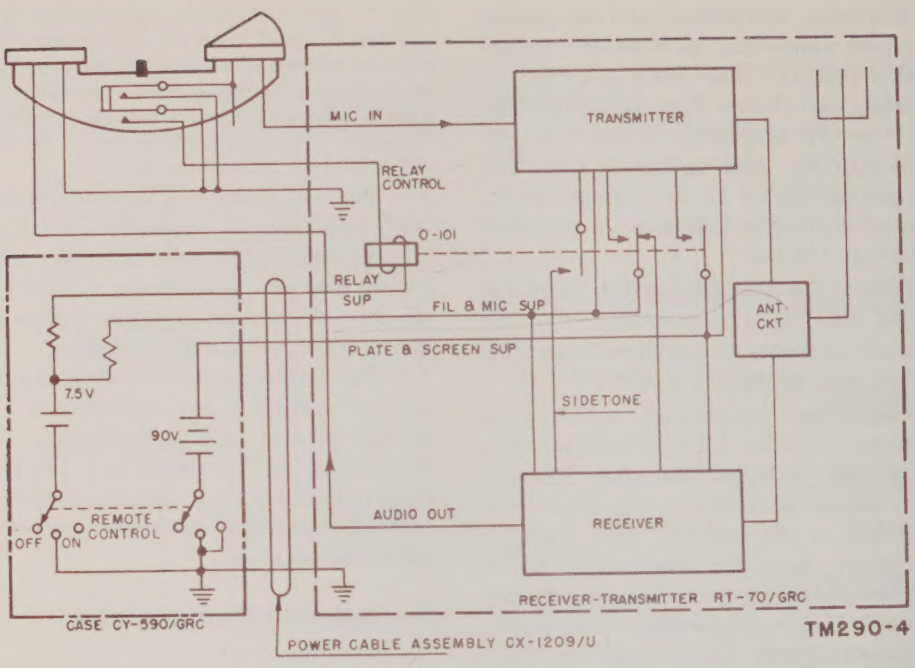



*Figure 3. Application of Receiver-Transmitter RT–70(*)/GRC to Radio Set AN/PRC–16, simplified block diagram.*

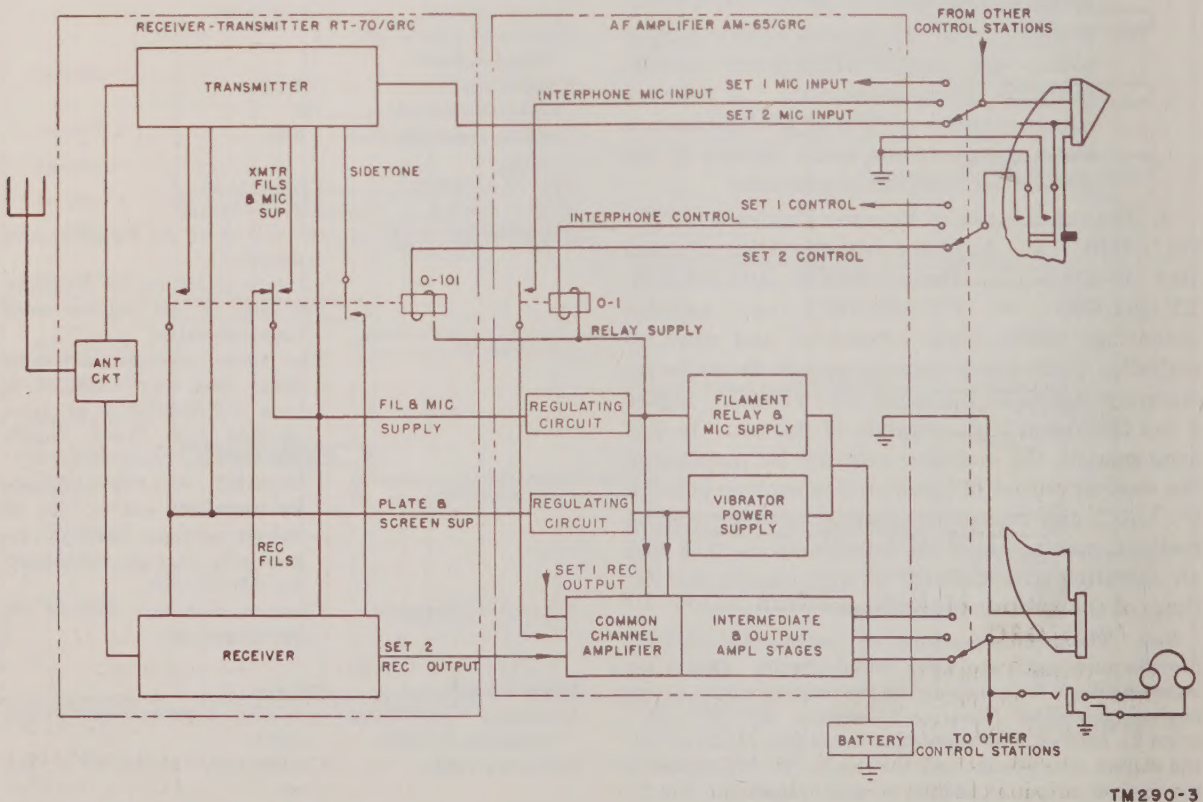



*Figure 4. Application of Receiver-Transmitter RT–70(*)/GRC to Radio Set AN/VRC–7, simplified block diagram.*

| | |
|---|---|
| Power input requirements: | |
| Plate and screen | 90 volts 80 ma. |
| Filament | 6.3 volts 360 ma. |
| Relay | 6.3 volts 160 ma. |
| Transmitter audio input impedance. | 150 ohms at 1,000 cps. |
| Transmitter audio input level | 0.25 volt rms at 1,000 cps. |
| *c. Receiver Circuit.* | |
| Type of receiver circuit | Double-conversion superheterodyne. |
| First intermediate frequency. | 15 mc. |
| Second intermediate frequency. | 1.4 mc. |
| Type of operational control. | Receiver normally in standby condition and silenced by squelch action. Turned on by signals having a minimum level determined by setting of SQUELCH control. |
| Sensitivity | 25-db signal-to-noise ratio at 1.0 microvolt with 15-kc deviation at 1,000 cps. |
| Bandwidth: | |
| 6 db down | 80 kc. |
| 20 db down | 120 kc. |
| 40 db down | Not over 180 kc. |
| Audio power output | 75 mw maximum for ±15-kc deviation at 1,000 cps. |
| Audio power output control. | Continuously variable by means of panel-mounted VOLUME control. |
| Audio output impedance | 600 ohms. |
| Noise suppression sensitivity (squelch). | ½ microvolt, approximately. |
| Squelch control | Continuously variable, panel-mounted SQUELCH control adjusts squelch sensitivity. OFF position of control disables squelch circuit. |
| Power input requirements: | |
| Plate and screen | 90 volts 80 ma. |
| Filament | 6.3 volts 360 ma. |
| *d. Calibration.* | |
| Calibrate frequencies | At each mc from 47 through 58 mc. |
| Built-in calibrate oscillator (crystal-controlled). | 1 mc. |
| Built-in oscillator (crystal-controlled). | 1.4 mc. |
| Accuracy of calibrate oscillator. | 0.01 per cent, approximately. |

## 6. Description of Receiver-Transmitter RT–70(*)/GRC

*a.* Receiver-Transmitter RT–70(*)/GRC is a combination double-conversion type superheterodyne receiver and FM transmitter with common antenna circuit. It is designed for the reception and transmission of FM voice signals within the continuously variable tuning range of 47 to 58.4 mc.

*b.* A front view of Receiver-Transmitter RT–70(*)/GRC is shown in figure 1. The unit is a compact, lightweight panel-and-chassis assembly with outer cover. All operating controls, cable connectors, and indicators are mounted on the front panel and are immediately accessible. A hole on the top of the outer cover gives access to the antenna trimmer capacitor. This hole is covered with a watertight cap. Snap catches are provided on the outer cover so that the unit can be mounted on AF Amplifier AM–65/GRC when it is used in a vehicular installation. The chassis may be removed by turning the Dzus fasteners on the front panel one-fourth turn to the left and sliding off the cover from the rear. The dimensions of the entire unit are 12⅞ inches by 7¼ inches by 5¼ inches. The weight of the complete unit with outer cover is 16¾ pounds.

*c.* Figures 5 through 8 show Receiver-Transmitter RT–70(*)/GRC removed from the case. The panel-and-chassis assembly consists of a front panel, a radio-frequency (RF) chassis, and an intermediate-frequency (IF) chassis. The RF chassis mounts the high-frequency (HF) components of both the transmitting and receiving circuits. The receiver IF components and the audio components of both the transmitter and receiver are mounted on the IF chassis. Both chassis are attached to projections at the rear of the front panel with screws and are arranged so that all internal tuning adjustment controls, tubes, and other plug-in parts are accessible without further disassembly of the unit. An important feature of the assembly is that a complete chassis can be substituted if either the RF or IF chassis of the set is defective.

(1) *Front panel.* The cast-aluminum front panel mounts all operating controls and connectors (fig. 1) and the dial-drive and detent mechanism (fig. 42). The dial-drive assembly, mounted on the rear of the front panel, couples mechanically to the shaft of RF tuning gang capacitor C10, mounted on the component side of the RF chassis. A set of allen wrenches is mounted in a bracket at the rear of the panel (fig. 42).

(2) *RF chassis* (figs. 6, 45, 46, and 47). The RF chassis is located on the right side of the panel-and-chassis assembly. It mounts the audio and RF components of the transmitter and HF portion of the receiver, variable 32- to 43.4-mc oscillator V2, and calibrate oscillator V7, including

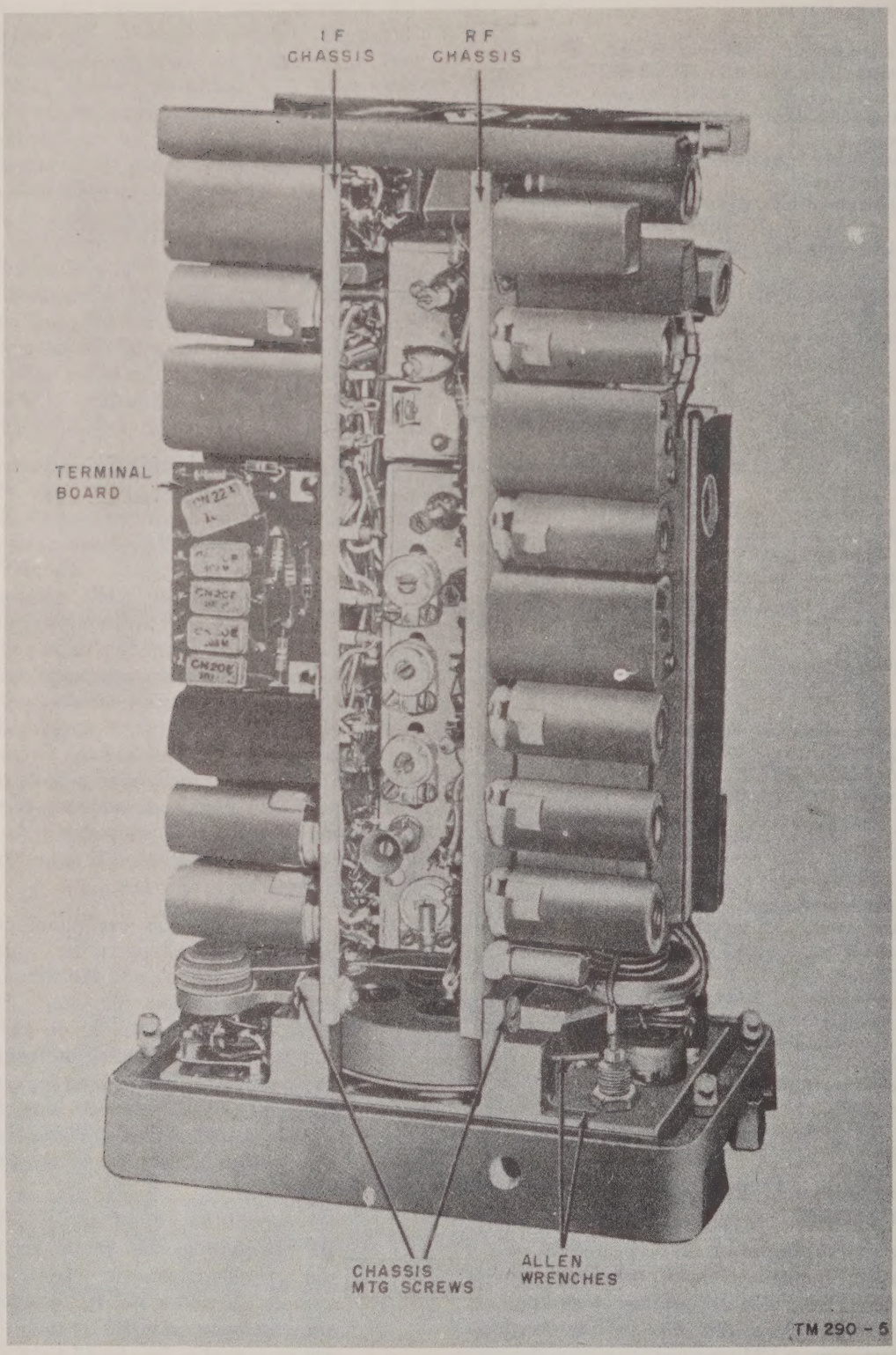



*Figure 5. Receiver-Transmitter RT–70(*)/GRC, case removed, top view of panel-and-chassis assembly.*

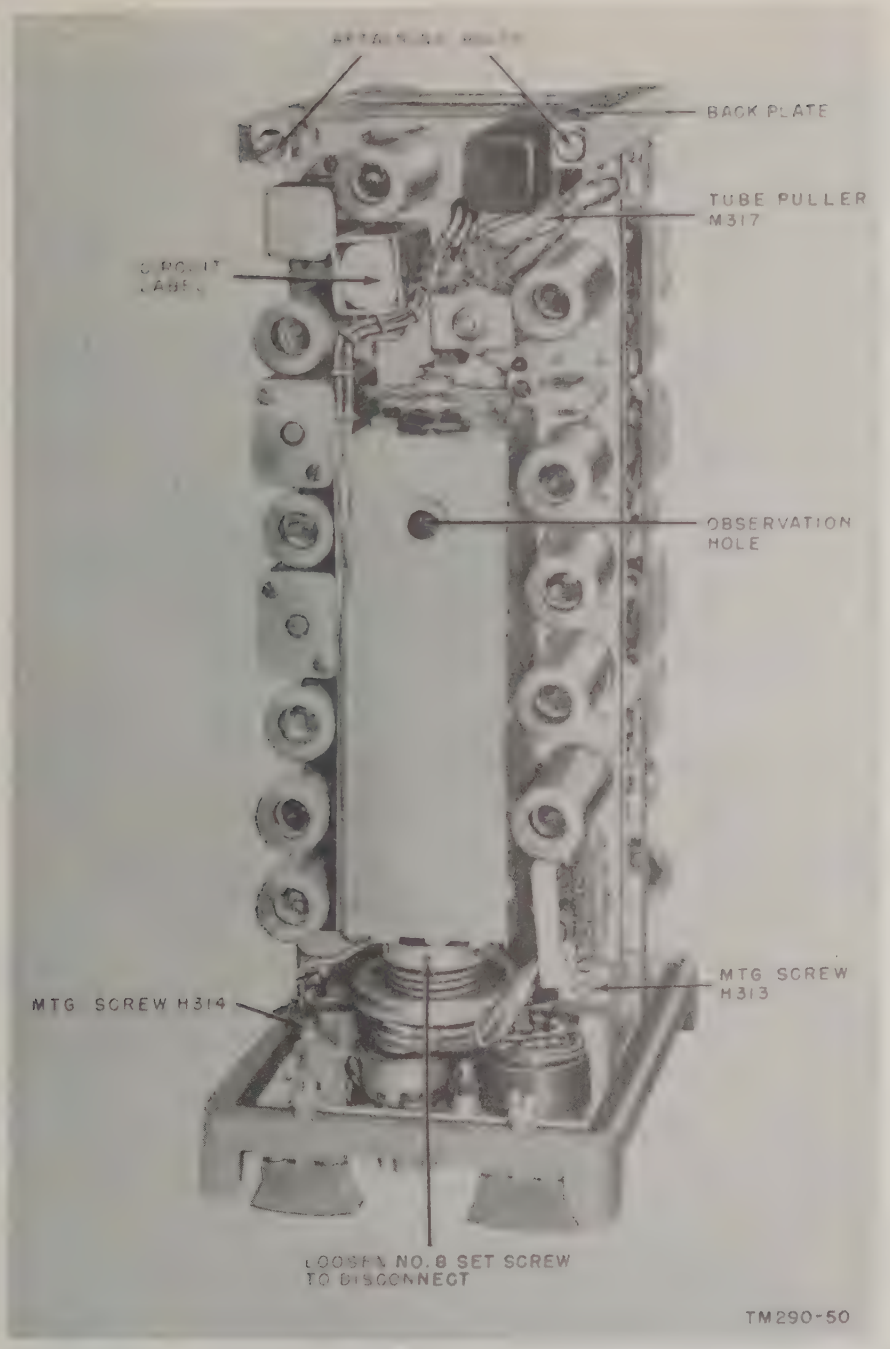



*Figure 6. Receiver-Transmitter RT-70(*)/GRC, case removed, view of RF chassis, right sight of panel-and-chassis assembly).*

gang tuning capacitor C10, crystals, and associated parts. A tube puller and a circuit label are provided on the RF chassis.

(3) *IF chassis.* The IF chassis (figs. 7, 43, and 44) mounts the components of the receiver IF amplifier, squelch, and audio circuits. The receiver-transmitter control relay and TANK-VEH-FIELD switch S101 are also mounted on the IF chassis.

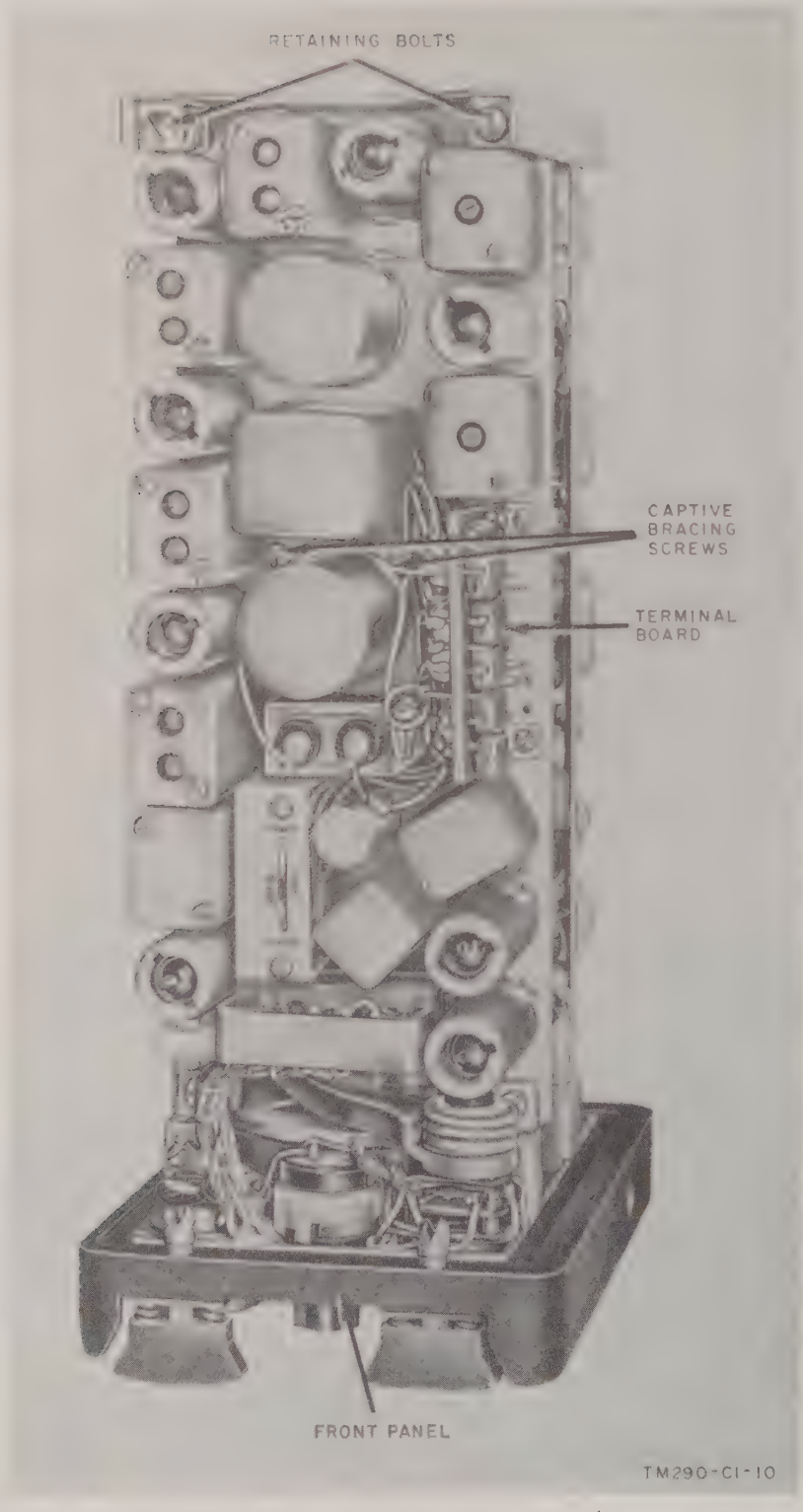



*Figure 7. Receiver-Transmitter RT–70(*)/GRC, case removed, view of IF chassis, left side of panel-and-chassis assembly.*

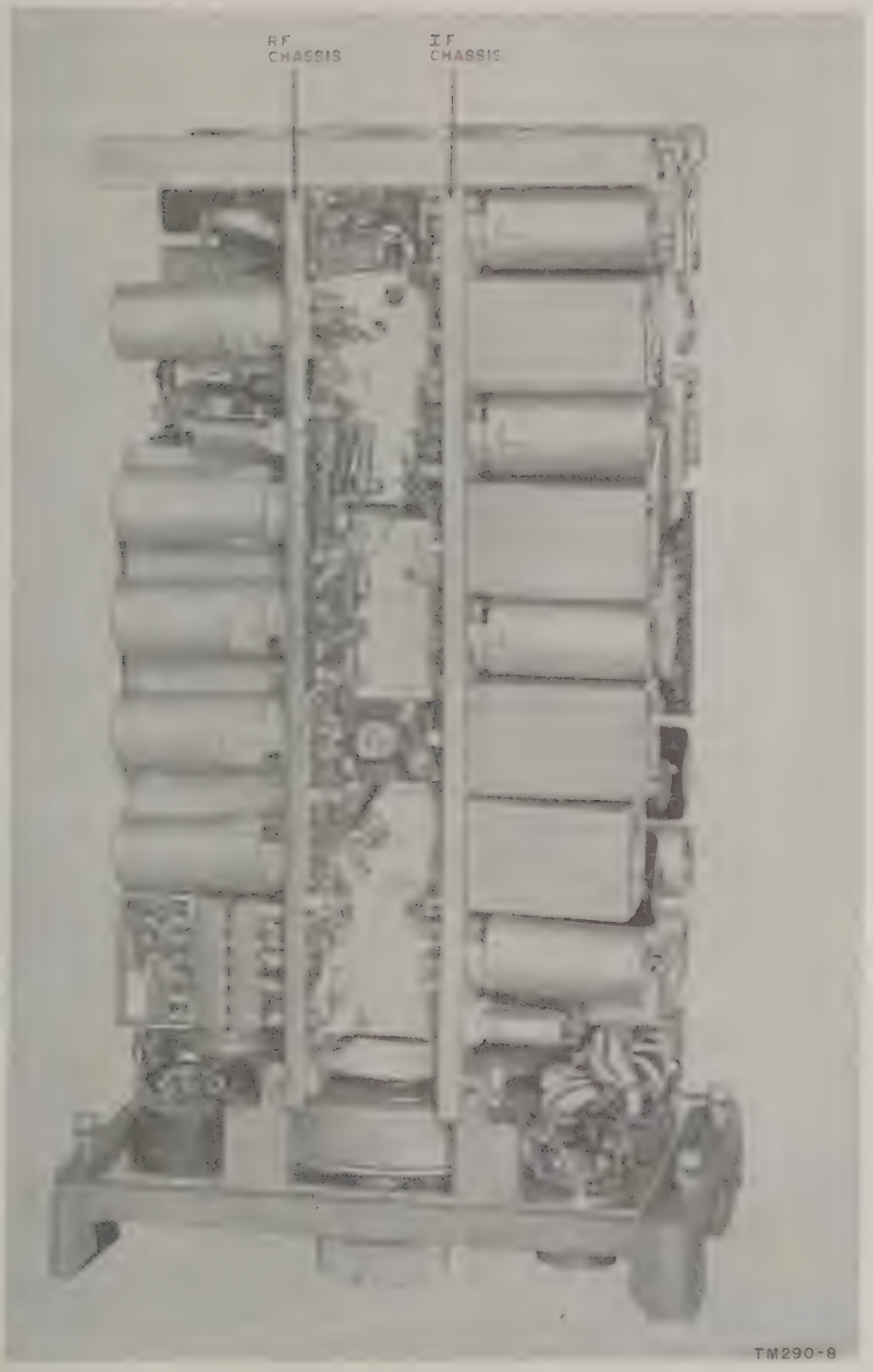



*Figure 8. Receiver-Transmitter RT–70(*)/GRC, case removed, bottom view of panel-and-chassis assembly.*

## 7. Controls, Instruments, and Connectors (fig. 9)

All operating controls and external connectors are on the front panel of the receiver-transmitter. Antenna tuning adjustment capacitor C41 (fig. 5) is accessible from the top of the outer cover when the cap is removed. The location of panel controls and connectors is shown in figure 9. The following chart lists the controls and connectors and indicates the function of each. In addition to the controls, connectors, and other items mounted on the panel, TANK-VEH-FIELD switch S101 is provided on the IF chassis inside the unit. This switch is set during initial installation to the position corresponding to the type of service to which the receiver-transmitter is to be put.

| Control or connector | Function |
|---|---|
| TENTH-MCS tuning knob. | Calibrated in tenths of an mc. Rotation of this knob tunes the receiver-transmitter over the frequency range of 47 to 58.4 mc. |
| MCS dial | Calibrated in mc from 47 through 58. One complete rotation of tuning knob changes dial setting by 1 mc. Frequency indication between mc markings obtainable from setting of TENTH-MCS tuning knob. Tuning frequency of set is sum of nearest lower dial number plus calibration marking on knob. |
| LOCK detent levers | Two levers, one on each side of the dial lamp. Each serves (independently of the other) to actuate a detent mechanism to detent or preset the dial-drive mechanism at any position within the tuning range. |
| Lamp (E201) | A pilot light above tuning knob which illuminates calibration markings of knob and dial. |
| SQUELCH control (R202 and S201). | This switch and potentiometer assembly serves to adjust the degree of the receiver squelch or noise quieting. In the maximum counterclockwise direction of rotation of the knob, the switch is turned off and the squelch (or receiver noise quieting circuit) is disabled, providing no receiver quieting. In the clockwise direction of rotation, increasingly stronger signals are required to disable the squelch and restore the receiver audio amplifier circuits to normal operation. For any setting of the potentiometer, a particular signal strength is determined, below which the receiver audio circuits are inoperative and above which signals may be heard. |
| VOLUME (R204) | This potentiometer serves to adjust the audio output of the receiver. |
| ANT ADJ-DIAL LIGHT (ON-OFF)-CAL switch (S202). | This four-position, wafer type switch has the functions tabulated below: |

| *Position* | *Function* |
|---|---|
| ANT ADJ | Turns on calibrate oscillator V7, provided the receiver-transmitter is in the receiving condition. The calibrate oscillator cannot be turned on when the receiver-transmitter is in the transmitting condition. The calibrate oscillator feeds into the receiver RF stage, a crystal-controlled source of RF test signal for alining the receiver-transmitter antenna circuit. Turns on dial illuminating LAMP E201 on the front panel. |
| DIAL LIGHT ON | Turns on dial illuminating lamp E201. |
| DIAL LIGHT OFF | Turns off the dial illuminating lamp. (A load equalizing resistor is substituted for the lamp when internal TANK-VEH-FIELD switch S101 is in the TANK or VEH position.) |
| CAL | Turns on calibrate oscillator V7 and 1.4-mc beat oscillator (part of V106) to provide a standard test frequency and a crystal-controlled comparison frequency, respectively, for the purpose of alining the receiver tuned circuits and for checking the calibration of receiver-transmitter main oscillator V2. The two signals combine in the receiver-discrimi- |

| Control or connector | Function | | Control or connector | Function | |
|---|---|---|---|---|---|
| | *Position* | *Function* | | *Position* | *Function* |
| | | nator circuit to produce a zero voltage or zero beat note as an indication of proper alinement, or a measurable voltage and an audible beat note as an indication of improper receiver calibration and alinement. Turns on dial illuminating lamp E201. | | | ADJ-DIAL LIGHT (ON-OFF)-CAL switch S202 is in the DIAL LIGHT OFF position.<br>(2) It places a dummy load across the 90-volt supply circuit when the receiver-transmitter is in the receiving condition and the screen supply circuit is disconnected from certain transmitter tubes. Maintains a constant drain on the 90-volt supply. |
| ANT connector (J201). | This is a small coaxial connector located in the top right-hand corner of panel. Serves to connect the lead from the common receiver and transmitter antenna to the antenna circuit inside the set. | | | VEH | Used when the receiver-transmitter is in an installation involving AF Amplifier AM-65/GRC and one of the vibrator power supplies. In this position, the switch performs the following functions:<br>(1) It equalizes the filament supply drain.<br>(2) It equalizes the 90-volt supply drain.<br>(3) It reduces the level of sidetone fed from the transmitter microphone circuit to the receiver audio circuits. |
| Antenna tuning adjustment (C41). | This is a screwdriver adjusted trimmer capacitor which is made accessible when the cap at the top of the outer case is removed. It serves to tune the common antenna circuits. | | | | |
| Antenna base holder | Two holes, at right angles to each other, permit attaching antenna Mounting MT-652/GR with Dzus type fasteners in either one of two positions. | | | | |
| AUDIO connector (J202). | This 10-pin multiconnector with male compression type contacts provides for connecting headphones, microphone, and microphone push-to-talk button to the receiver output and the transmitter audio input circuits, respectively. A through connection is also provided between a pin on this connector and the POWER connector for an external power control circuit. | | | | |
| TANK-VEH-FIELD switch S101. | TANK | Used when the receiver-transmitter is in an installation involving AF Amplifier AM-65/GRC, one or more monitoring positions through the amplifier and Control Box C-375/VRC, and the use of Power Supply PP-281/GRC, PP-282/GRC, or PP-448/GR. In this position, the switch performs the following functions:<br>(1) It substitutes a dummy load across the filament supply in place of the dial light, when ANT | | FIELD | Used when the receiver-transmitter is in a portable installation in which the amplifier is not used. Power is derived from a set of dry batteries (Case CY-590/GRC) and no monitoring or interphone positions are involved. In this position, the switch performs the following functions:<br>(1) The dummy loads are disconnected.<br>(2) The level of sidetone to the receiver audio circuits is reduced. |

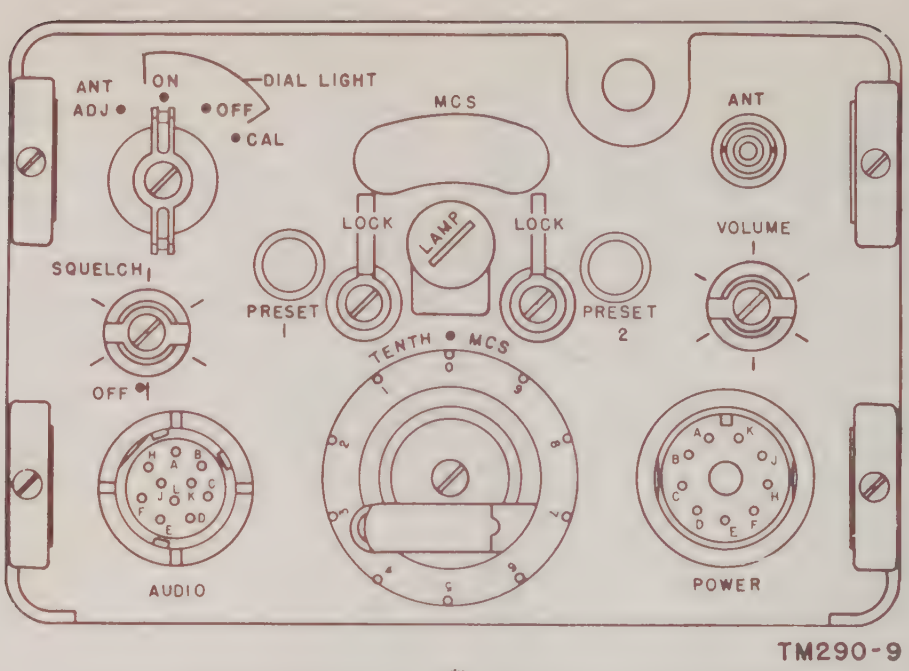



*Figure 9. Receiver-Transmitter RT–70(*)/GRC, panel controls and connectors.*

## 8. Additional Equipment Required

The following materials are *not* supplied as part of Receiver-Transmitter RT–70(*)/GRC, but are required for its installation and operation: a microphone and headset, or a handset with push-to-talk button; an antenna with mounting components and hardware; a source of 90-volt plate and screen power and a source of 6-volt filament and relay power; suitable control boxes and mounting facilities; connecting cables; and a set of spare parts. The number and type of components necessary to complete a working installation differs from one installation to another, depending on the nature of the system in which the receiver-transmitter is used. The materials normally supplied for two typical installations are detailed in *a* and *b* below.

*a. Portable Installation (Radio Set AN/PRC–16).* For a portable installation, such as Radio Set AN/PRC–16, the following materials normally are supplied:

(1) Receiver-Transmitter RT–70(*)/GRC.
(2) Case CY–590/GRC, including the required set of dry batteries (90 volts and 7.5 volts).
(3) Mounting MT-673/UR.
(4) Mounting MT–652/GR.
(5) Mast Section AB–22/GR.
(6) Mast Section AB–24/GR.
(7) Power Cable Assembly CX–1209/U.
(8) Handset with push-to-talk button—Handset H–33(*)/PT.
(9) TM 11–282, Radio Set AN/FRC–15.

*b. Vehicular Installation (Radio Set AN/VRC–7).* For a vehicular installation, such as Radio Set AN/VRC–7, the following materials normally are supplied:

(1) Receiver-Transmitter RT–70(*)/GRC.
(2) Interphone amplifier with suitable vibrator type power supply—AF Amplifier AM–65/GRC and one PP–448/GR, PP–281/GRC, or PP–282/GRC.
(3) Vibrator type power supply. One of Power Supply PP–448/GR, PP–281/GRC, or PP–282/GRC, depending on whether the storage battery voltage is 6, 12, or 24 volts, respectively. (The power supply is housed in a compartment of AF Amplifier AM–65/GRC, (2) above.)
(4) Mounting MT–300/GR.
(5) Vehicular antenna components, as follows:
  (*a*) Mast Base AB–15/GR.
  (*b*) Mast Section AB–22/GR.
  (*c*) Mast Section AB–24/GR.
(6) Interphone operation control unit—Control Box C–375/VRC.
(7) Remote control equipment—Control Group AN/GRA–6, including Local Control C–434/GRC and Remote Control C–433/GRC (optional).

(8) Rf Cable Assembly CG–530/U (4 ft., 2 in. long).
(9) Special Purpose Cable WM–46/U.
(10) Special Purpose Cable Assembly CX–1213/U.
(11) Connector and bondnut (Appleton Electric No. 61007 and BL–50) or equal.
(12) Adapter UG–273/U.
(13) Adapter UG–306/U.
(14) Bag CW–206/GR.
(15) Case CY–684/GR.
(16) TM 11–285, Radio Set AN/VRC–7.

*Note.* The above lists are intended for illustrative purposes only. Detailed information on parts and additional equipments supplied for a particular installation is given in the technical manual for the particular system.

## 9. Running Spare Parts and Tools

*a. Running Spare Parts.* The following running spare parts are supplied with each Receiver-Transmitter RT–70(*)/GRC.

1 GH–1992–1 lamp incandescent or Mazda 331.
1 type 3B4 tube.
6 type 3Q4 tubes.
2 type 3A5 tubes.
2 type 1L4 tubes.
10 type 1U4 tubes.
2 type 1R5 tubes.
1 type 1S5 tube.
1 type 1AE4 tube.

*b. Tools.* The following tools are supplied with each Receiver-Transmitter RT–70(*)/GRC.

(1) Allen wrench No. 6 and No. 10 (fig. 5).
(2) Tube puller (fig. 6).

## 10. Differences in Models

*a.* The following changes have been made in all models of Receiver-Transmitter RT–70(*)/GRC except those with serial numbers from 1 through 747 on Order No. 18651–Phila–49.

(1) The value of resistor R2 is changed from 470,000 onms to 270,000 ohms and, instead of being connected across C1, is connected between pin 3 of V1 and terminal 4 of T2.
(2) The value of resistor R3 is changed from 27,000 ohms to 82,000 ohms.
(3) Resistor R35, 3,300 ohms, is added between terminal 4 of T2 and ground.
(4) The value of resistor R140 is changed from 470,000 ohms to 220,000 ohms.

*b.* In all models except those with serial numbers from 1 through 4122 on Orders No. 18651–Phila–49 and 1759–Phila–51, 6371 through 7158 on Order No. 16832–Phila–51, and 14232 through 14325 on Order No. 16822–Phila–51, capacitor C159, .01 microfarad ($\mu$f) is added across terminal 4 of T101 and ground.

*c.* In models of Receiver-Transmitter RT–70/GRC with serial numbers 1 through 888 on Order No. 2884–Phila–52, C161 (3,000 micromicrofarads ($\mu\mu$f)) is added across C106.

*d.* Receiver-Transmitter RT–70A/GRC, on Orders No. 2884–Phila–52 (serial numbers 889 through 4700), No. 2908–Phila–52 (serial numbers 1 through 12927), No. 2918–Phila–52 (serial numbers 1 through 16077), and No. 2925–Phila–52 (serial numbers 1 through 12800), differs from Receiver-Transmitter RT–70/GRC in the following respects:

(1) The filament circuits are rearranged to insure uniform distribution of the proper filament voltage across each tube filament (fig. 33).
(2) Receiver-Transmitter RT–70A/GRC uses a 3A5 twin triode for first audio amplifier and beat oscillator stage V106, in place of the 1R5 pentagrid converter used in Receiver-Transmitter RT–70/GRC. The circuits of V106 are modified (fig. 54).
(3) To accommodate the change in tube type indicated in (2) above, the filament circuits of V106, V108, V4, and V2, in the same series-parallel filament string, are modified (fig. 33).
(4) The value of capacitor C47 is changed from .5 $\mu\mu$f to 2 $\mu\mu$f.
(5) The value of capacitor C109 is changed from 30 $\mu\mu$f $\pm$10 percent to 39 $\mu\mu$f $\pm$5 percent.
(6) Capacitor C161 (3,000 $\mu\mu$f) is added across C106.

## 11. Modifications of Equipment

The modification work orders listed in *a* through *g* below give changes or modifications of the components or circuits of Receiver-Transmitter RT–70/GRC. Equipment on which these modification work orders have been performed may differ in circuitry or parts from the equipment described in this manual.

*a.* MWO Sig 11–290–1, Modification of Receiver-Transmitter RT–70/GRC to Provide a Tube Guard for Protection of Tubes V106, V107, and V108.

*b.* MWO Sig 11–290–2, Modification of Receiver-Transmitter RT–70/GRC to Provide Improved-Type Spring-Locking Clips on R-F Coils.

*c.* MWO Sig 11–290–3, Modification of Receiver-Transmitter RT–70/GRC to Prevent Audio Feedback.

*d.* MWO Sig 11–290–4, Modification of Receiver-Transmitter RT–70/GRC to Replace the Existing 9-Pin Amphenol Connector J203 with an Improved Connector.

*e.* MWO Sig 11–290–5, Modification of Receiver-Transmitter RT–70/GRC to Prevent Erratic Limiting Action in the Receiver.

*f.* MWO Sig 11–290–6, Modification of Receiver-Transmitter RT–70/GRC to Increase the Amplitude of the Beat Note of the Crystal Calibrator.

*g.* MWO Sig 11–290–7, Modification of Receiver-Transmitter RT–70/GRC to Provide the Same Operational Characteristics as Receiver-Transmitter RT–70A/GRC.

# CHAPTER 2

# THEORY OF RECEIVER-TRANSMITTER RT-70(*)/GRC

## 12. Block Diagram
(fig. 10)

*a. General.* The signal path of the receiver-transmitter is shown in the functional block diagram (fig. 10). A complete schematic diagram of the equipment is shown in figures 53 and 54. The block diagram shows that the equipment consists of a separate transmitter circuit and a separate receiver circuit. The two circuits are associated with each other through a common antenna circuit, a common 32- to 43.4-mc oscillator, V2, and a common tuning control. Normally, the receiver is operative while the transmitter is in a standby or inoperative condition. When the microphone button is operated, the receiver is effectively turned off and the transmitter is turned on. This function is accomplished by a relay control circuit also indicated on the block diagram. The frequency range of the transmitter and of the receiver is from 47 to 58.4 mc. This range corresponds to 115 channels of 100 kc each.

*b. Transmitter Signal Path.* The function of the transmitter is to convert speech signals from an external microphone, amplifier, telephone line, or other audio-frequency (AF) source into FM RF signals. This is accomplished by causing the AF signals to shift the frequency of a locally generated carrier frequency which is then transmitted over the air. Voice signals from the external microphone, amplifier, or telephone line are amplified by microphone amplifier stage V1 to the proper value for modulation (pars. 18 and 19). Audio voltages are applied to the modulator to vary the frequency generated by variable oscillator V2 (par. 20) in accordance with the amplitude and frequency of the audio signal. The outputs of 32- to 43.4-mc oscillator V2 and 15-mc transmitter oscillator V3 (par. 22) are combined in mixer stage V4 (par. 23). The desired sum frequency at the output of the transmitter mixer is selected by a tuned circuit and is applied to transmitter driver stage V5 (par. 24). The signal is amplified again and is applied to transmitter power amplifier stage V6 (par. 25). The amplified output is then routed through a tuned antenna circuit to the antenna (par. 26). No antenna switching is provided since the receiver is inoperative when the transmitter is energized.

*c. Receiver Circuits.* The function of the receiver is to accept FM carrier signals and to convert them by a double-conversion process and by means of an FM discriminator into the originally transmitted audio signals. The audio signals then are applied to an external headset, the earpiece of a handset, and audio amplifier, a telephone line, or some other suitable AF receiving device. Carrier signals from the antenna are applied through the common antenna circuit to first RF amplifier stage V8 (par. 27), the output of which is tuned by a section of the variable gang capacitor. The amplified output of this stage and the output of common variable oscillator V2 (*b* above) is applied to mixer stage V9 (par. 28) which produces sum and difference frequencies. The difference frequency is selected by the tuning circuit of the mixer and is routed as a band of frequencies centered about 15 mc to a three-stage IF amplifier (V10, V11, and V101) (par. 29). The 15-mc output of V101, in conjunction with the second harmonic of the 6.8-mc oscillator (part of V102), is combined in the receiver second mixer portion of V102 (par. 30) to produce a second IF centered about 1.4 mc. This signal is amplified again in a three-stage amplifier limiter (V103, V104, and V105) (par. 31). The first stage (V103) is a conventional 1.4-mc IF amplifier. The second and third stages (V104 and V105) have the additional function of limiting (or eliminating) any amplitude variations of the signal. Such amplitude variations represent noise or interference and are, therefore, undesirable. In addition, the proper functioning of discriminator T107, which follows second limiter V105, requires that the level of the applied signal be fairly uniform for variations in the level of the incoming signal. The output of the second limiter stage is applied to discriminator circuit T107 which functions to demodulate the audio signal from the incoming carrier signal (par. 32). The discriminator converts variations from the center frequency of the incoming signal into audio signals. These audio signals appearing at the output of the discriminator are amplified in two-stage audio amplifier V106 and V108 (pars. 33 and 34) and are applied to the receiver output terminals of the panel-mounted AUDIO and POWER connectors. The panel-mounted VOLUME control is located elec-

trically between the output of the first and the input of the second audio amplifier stages.

*d. Sidetone.* A portion of the audio signal applied to the transmitter is routed over a special path, called a sidetone path, to the receiver audio circuits where it is amplified and becomes audible in the earpiece of the handset or in the headset of the operator (par. 37). This sidetone signal is useful because it permits monitoring the transmission and it imparts a natural effect in the earpiece of the handset. Without sidetone, the circuit would seem dea

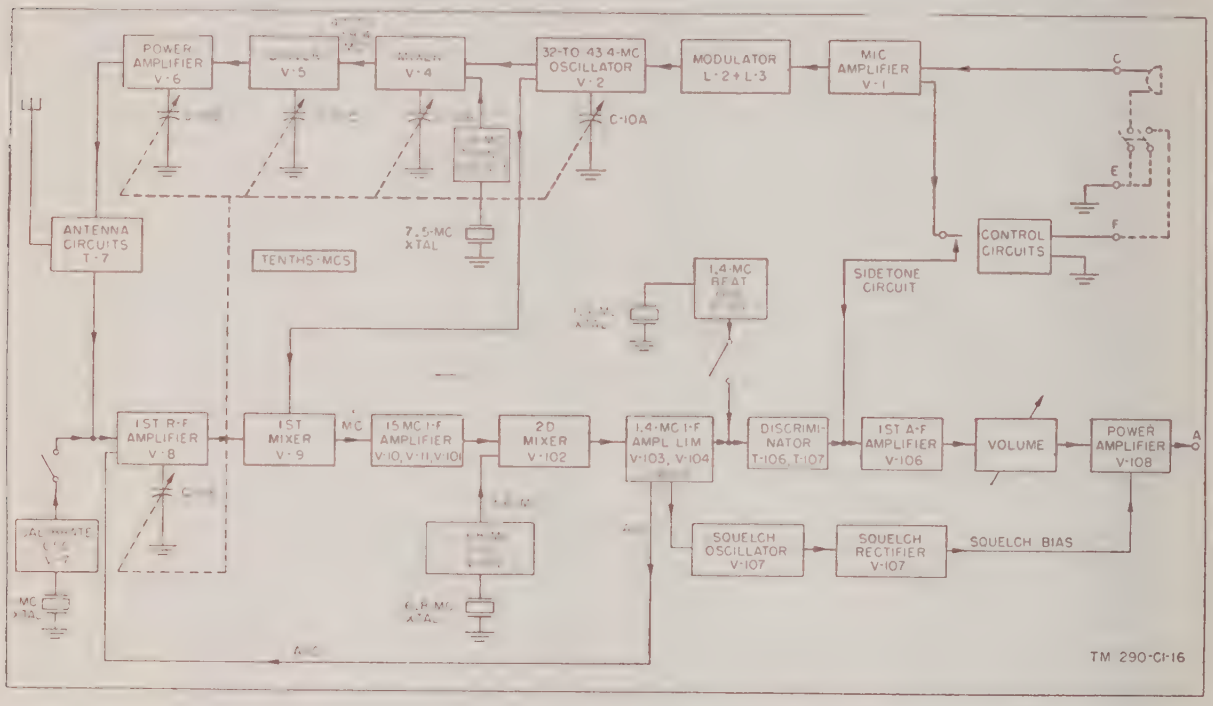



*Figure 10. Receiver-Transmitter RT–70/GRC, functional block diagram.*

## 13. Transmitter Carrier Frequency and Receiver IF Generation

As shown in figure 10, three oscillators serve to produce the transmitting carrier frequency and the receiver intermediate frequencies. These are 32- to 43.4-mc oscillator V2, 15-mc transmitter oscillator V3 (15-mc output), and the fixed second if 6.8-mc oscillator (13.6-mc output) which uses (part of V102).

*a. 32- to 43.4-mc Oscillator V2.* Variable self-excited common oscillator V2 is tunable over its frequency range of 32 to 43.4 mc by gang tuning capacitor C10A. The frequency generated by this oscillator is always 15 mc below the receiver-transmitter operating frequency. This means that for any setting of the tuning capacitor, the variable oscillator frequency is 15 mc below the ultimate desired transmitting frequency, and 15 mc below the frequency to which the receiver is tuned. The output of the variable oscillator is fed over two paths. One path applies the oscillator output to receiver first mixer V9 where, during reception of a signal, the first IF of 15 mc is produced. The other path applies the output of the oscillator to transmitter mixer V4. There the variable oscillator frequency combines with the output of 15-mc transmitter oscillator V3 to produce a sum frequency which is the desired transmitter carrier frequency. During transmission, the output of the variable oscillator is frequency-modulated by the voice signals entering the transmitter circuits from the microphone or other audio device.

*b. 15-mc Transmitter Oscillator V3.* Fixed-frequency crystal-controlled oscillator V3 produces a frequency of 7.5 mc. The second harmonic of this frequency (15 mc) is selected and applied to transmitter mixer V4 together with the output of variable common oscillator V2. The resultant sum frequency is the desired transmission frequency.

*c. 13.6-mc Oscillator V102.* A portion of tube V102 is used in a fixed-frequency crystal-controlled

oscillator circuit producing a frequency of 6.8 mc. The second harmonic of this frequency fed to the receiver second mixer (another portion of V102), beats with the first IF (15 mc), producing the second IF (1.4 mc).

## 14. Receiver-Transmitter Common Circuit Elements

(figs. 53 and 54)

In addition to common 32- to 43.4-mc variable oscillator V2 (par. 20) the elements described below are also common to the receiver and to the transmitter.

*a. Tuning Elements.* The receiver and transmitter are always tuned to the same operating frequency. Selection of the desired operating frequency is accomplished by the continuously variable tuning control on the front panel. Varying this control varies gang tuning capacitor C10, the five sections of which are associated with the tuned receiver-transmitter rf stages as tabulated below. The chart also shows the trimmer capacitors associated with each variable tuned circuit.

Receiver-Transmitter RT–70(*)GRC RF Circuits

| Stage or circuit | Capacitor | Section capacity range | Trimmer |
|---|---|---|---|
| 32- to 43.4-mc oscillator V2 | C10A | 14 to 77 $\mu\mu$f | C4 (3–15 $\mu\mu$f) and tracking plates.* |
| Transmitter mixer V4 | C10B | 11 to 36 $\mu\mu$f | C27 (3–12). |
| Transmitter driver V5 | C10C | 11 to 36 | C34 (3–12). |
| Transmitter power amplifier V6 and antenna circuit. | C10D | 11 to 36 | C41 (3–15). |
| Transmitter neutralizer circuit. | ---------- | ---------- | C35 (.3–3.0). |
| Receiver RF stage V8 | C10E | 11 to 36 | C56 (3–12) |
| Calibrate oscillator V7 | ---------- | ---------- | C48 (3–12). |

* The slotted tracking adjustment plates (fig. 6), mounted at the rear of the gang capacitor, serve to straighten out the oscillator tuning capacity versus dial rotation curve (i.e. calibration). Adjustment is made by bending the segment corresponding to the particular mc setting of the dial. For adjustment details, see paragraph 74*e*.

*b. Antenna Circuit.* Since the transmitting frequency is always the same as the receiving frequency, and only the transmitter or the receiver is on at any one time, a common antenna circuit is used. Gang capacitor C10D and trimmer capacitor C41 tune the antenna circuit to resonance at the operating frequency.

*c. Control Circuits.* In effect, the receiver-transmit control circuit applies full power to either the transmitter when relay O 101 in the control circuit is energized or to the receiver when the control relay is deenergized (par. 36). Relay O 101 is energized when ground return to the relay is made, and is deenergized when ground return is broken. Application or removal of ground return may be accomplished either by the push-to-talk function of a microphone directly or through a sequence of other external relays, depending on the arrangement of the system in which the receiver-transmitter is used.

## 15. Modulation

The 32- to 43.4-mc oscillator frequency is modulated by varying the inductance of coil L2B connected in series with oscillator tuning coil L3 (fig. 13). The inductance of this small modulating coil is changed by varying the permeability of the iron dust core upon which it is wound. To accomplish this, the coil is placed in the magnetic field of larger AF coil L2A, which is energized by the microphone amplifier when the operator talks into the carbon microphone connected to the receiver-transmitter. The iron dust core is also magnetically biased by a permanent magnet to provide a proper center operating point. Modulation is represented by a shift of about $\pm 15$ kc in the frequency generated by variable oscillator V2, and ultimately by a shift in the overall carrier frequency.

## 16. Squelch Circuit

It is characteristic of very sensitive receivers that in the absence of a received signal a rushing noise is heard in the receiver phones or loudspeaker. The noise is the result of thermal agitation in the vacuum tubes and receiver components and of external electrical disturbances. A *squelch* circuit is, therefore, used to suppress this annoying noise during no-signal intervals. In Receiver-Transmitter RT–70(*)/GRC, the squelch circuit consists of a carrier-switched 30-kc (approximately) oscillator followed electrically by a diode rectifier. Both the oscillator and diode rectifier are in the same envelope of multipurpose tube V107. When the receiver is in a squelched condition and no signal is being received, the squelch circuit is operative and biases the audio amplifier to cutoff. When a signal is received which has the proper signal strength, the squelch is disabled and the audio amplifier is restored to normal operation. Squelch action is adjustable by means of panel-mounted SQUELCH control R202. The OFF position of this control operates switch S201 and disables the squelch for

test purposes or for reception of weak or fading signals. The squelch circuit is described in greater detail in paragraph 35.

## 17. Calibrating and Test Circuit

A calibrating circuit associated with the receiver includes 1-mc crystal-controlled oscillator V7, the output of which is very rich in harmonics, and a 1.4-mc oscillator derived from a portion of first audio amplifier tube V106 and ANT ADJ-DIAL LIGHT (ON-OFF)-CAL test switch S202.

*a. Calibrate Oscillator.* A signal for use in calibrating the receiver at frequency settings of the dial which are multiples of 1 mc is generated by crystal oscillator V7 (par. 38). This oscillator is coupled to the input of first RF amplifier tube V8 of the receiver. When the test switch is in either the ANT ADJ or in the CAL position, the oscillator is turned on and generates a frequency of 1 mc. The harmonics of this signal are selected by the tuned circuits of the receiver, the particular harmonic selected depending on the frequency to which the receiver is tuned.

*b. Beat Oscillator.* When the test switch is in the CAL position, first audio amplifier stage V106 functions as a combined 1.4-mc crystal oscillator and an audio amplifier (par. 39). The output of this oscillator is connected at a point ahead of the discriminator rectifiers. Since the frequency generated by this oscillator is the same as that to which the 1.4-mc if amplifier is tuned, a zero beat is obtained at the output of the discriminator when a 1.4-mc signal enters the discriminator. An audio beat note is obtained when the incoming signal to the RF stage is not a multiple of 1 mc, thereby causing the signal at the discriminator input to be different than 1.4 mc. This AF beat enables the operator to make precise frequency adjustments.

*c. Use.* If either the 13.6-mc oscillator or the 32- to 43.4-mc oscillator is off frequency, the signal entering the discriminator circuit will not be 1.4 mc and, therefore, an audible beat note will be heard. However, as long as the oscillators are all on frequency, a zero beat note will be obtained. The calibrate oscillator alone can be used to check the tuning of the antenna circuit at every megacycle point, since proper alinement will cause quieting of the noise in the receiver. The combination of the beat oscillator and the calibrate oscillator may be used to check the following (par. 40):

(1) The calibrate oscillator (V7).
(2) The receiver 13.6-mc oscillator (part of V102).
(3) The tuning of common 32- to 43.4-mc oscillator V2.
(4) The tuning of the overall receiver.

## 18. Microphone Input Circuit (fig. 11)

*a.* Two parallel input connections for the audio signal and control circuit of the microphone, or another source of audio modulation to be transmitted, are provided. One input connection is at terminals C and E (ground) of AUDIO connector J202, and the other at terminals C and D (ground) of POWER connector J203. The microphone circuit of Receiver-Transmitter RT–70(*)/GRC extends over terminals 2 of chassis connectors P201 and J1 to the 150-ohm primary winding (terminals 6 and 7) of microphone transformer T1. The ground return path for the audio signals is completed over terminals 4 of J1 and P 201 and terminals 4 of P202 and J101, through dual capacitor C157.

*b.* Direct-current (dc) voltage for energizing the carbon button of the microphone is applied from an external 6-volt dc source (filament supply) to terminals F and D (ground) of J203. The 6-volt microphone supply circuit extends from terminal F of J203, through terminals 13 of P202 and J101, through the normally open contacts 2 and 3 of control relay O 101, over terminals 15 of J101, P202, P201, and J1, and through voltage-dropping resistor R1 to terminal 7 of the primary winding of T1. The microphone supply voltage is filtered by capacitor C157B and C157A.

*c.* Contacts 2 and 3 of relay O 101 close and apply microphone energizing voltage when the microphone push-to-talk button is closed or when, through some other external circuit arrangement, ground return for the coil of relay O 101 is completed (par. 36).

*d.* The signal voltage developed across winding 6–7 of T1 is induced into secondary winding 1–2–3 of that transformer for application to the microphone amplifier (par. 19). The portion of the signal developed across winding 1–2 of T1 is routed over the sidetone circuit to the receiver audio amplifier stages. The sidetone circuit is described in paragraph 37.

## 19. Transmitter Microphone Amplifier V1 (figs. 11 and 12)

The transmitter microphone amplifier uses a tube type 3Q4 pentode, V1, in a conventional class A audio amplifier circuit. The purpose of this stage

is to raise the level of the speech signals to the proper value for modulating the transmitter.

*a. Preemphasis Circuit.* The high impedance secondary winding 1–2–3 of microphone transformer T1 is connected to the grid of V1 through a shaping circuit consisting of capacitor C1 and resistors R2 and R3 (R2 not used in Receiver-Transmitter RT–70A/GRC). The shaping circuit accentuates the higher audio frequencies to provide preemphasis during transmission. This arrangement is used to increase the carrier frequency deviation per audio input volt for the higher audio frequencies, so that at the receiving end the signal-plus-noise to noise ratio will be effectively increased.

*Notes.*

1. In all models except those with serial numbers from 1 through 747 in Order No. 18651–Phila–49 (fig. 11), resistor R2, 470,000 ohms, is removed and resistor R2, 270,000 ohms, is connected between terminal 4 of transformer T2 and pin 3 of tube V1; the value of resistor R3 is increased from 27,000 ohms to 82,000 ohms; capacitor C2 is removed; and an additional resistor, R35, is connected across pins 4 and 6 of T2. The removal of R2 from the grid circuit and C2 from the plate circuit increases the high-frequency preemphasis provided by this stage. The addition of R35 across 4 and 6 of T2 broadens the frequency response of the amplifier. The connection of the new R2 from pin 4 of T2 to pin 3 of V1 provides a negative feedback circuit to R3 and the grid of V1. This circuit decreases the distortion and broadens the response of the amplifier.

2. In all models except those with serial numbers from 1 through 747 on Order No. 18651–Phila–49 (fig. 12), the value of resistor R140 is changed from 470,000 ohms to 220,000 ohms, and the value of resistor R138 is changed from 150,000 ohms to 56,000 ohms. When switch S101 (TANK-VEH-FIELD) is at either VEH or FIELD, these two resistors form a voltage divider for that portion of the audio voltage which is developed across pins 1 and 2 of T1. The values of the two resistors are changed to reduce the sidetone signal by developing a smaller audio voltage across R138 than that obtained with the former values. When switch S101 is at TANK, the full voltage across pins 1 and 2 of T1 is applied to the sidetone circuit.

*b. Plate Load Impedance.* The plate load impedance of V1 consists of primary winding 1–2–3 of output transformer T2 shunted by capacitor C2. The parallel resonant plate load tends to shape the frequency response of the amplifier and to peak it at approximately 2,000 cycles.

*c. Plate and Screen Supply Circuits.* The plate (pins 2 and 6 tied internally) and the screen grid (pin 4) of tube V1 obtain their operating potentials from the external 90-volt supply. The plate supply circuit extends from pin J of J203, through decoupling resistor R205, through pins 7 of chassis connector P201 and J1, and through winding of 1–2–3 of T2. The screen supply circuit extends from pin J of J203 through R205, pins 11 of P202 and J101, over normally open contacts 8–9 of relay O 101, pins 1 of J101 and P202, and pins 5 of P201 and J1. When O 101 is energized, contacts 8–9 close and complete the above circuit. When relay O 101 is not energized, the screen circuit is open and normally closed contact pair 5–4 places current compensating resistor R136 across the 90-volt supply. Ground return for this resistor is provided when switch S101 is in either the TANK or VEH position. For a detailed description of the plate and screen supply circuits, see paragraph 41. For a detailed description of the control circuits, see paragraph 36.

*d. Bias.* Bias for the tube is provided by the voltage drop across the filament of V6.

*e. Filament Circuits.* Filament voltage for V1 is obtained from the 6-volt filament supply connected to terminal F of J203. In Receiver-Transmitter RT–70A/GRC, the filament supply circuit for V1 extends from pin F of J203, through pins 13 of connectors P202 and J101, and over normally open contacts 2–3 of relay O 101, contacts 15 of J101 and P202, P201, and J1 (fig. 33). The circuit continues through filament voltage-dropping resistor R40 and isolating choke L1 to pin 7 of V1. The other side of the filament connects to the filaments of other transmitter tubes. Filament voltage is applied when relay O 101 becomes energized and closes and contacts 2 and 3. When the transmitter is in standby condition, these relay contacts are open and no filament voltage is applied to V1. The filament circuits of the receiver-transmitter are described in paragraph 42. For control circuit details see paragraph 36.

## 20. Common 32- to 43.4-mc Oscillator V2 (fig. 13)

The self-excited 32- to 43.4-mc oscillator uses a type 3A5 twin-triode tube, V2, in a Colpitts circuit. To obtain maximum transconductance, the two triode sections of the tube are connected in parallel by joining the two plates, pins 2 and 6, and the two grids, pins 3 and 5.

*a. Tuned Circuit.* The oscillator is tuned to resonance by the parallel resonant circuit composed of series inductors L3 and L2B and by C10A, a section of the receiver-transmitter main tuning capacitor. The parallel group of capacitors C5, C6, C7, and C9, connected in series with the variable capacitor section, provides the series padding

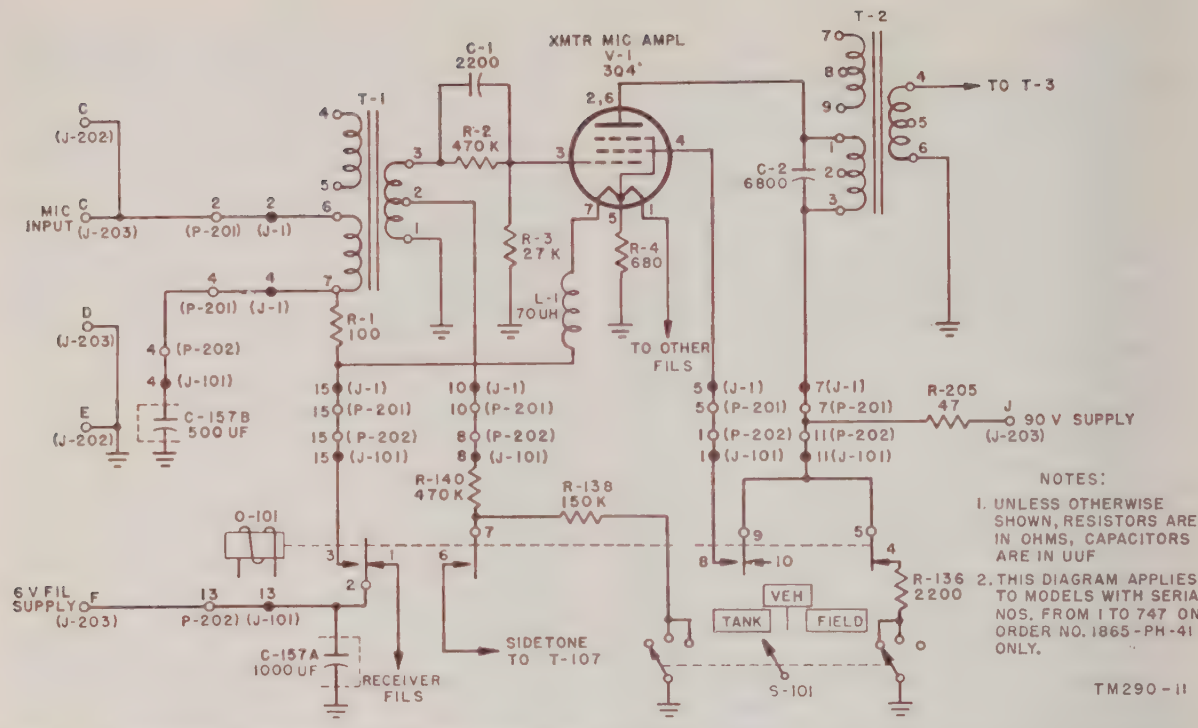



*Figure 11. Microphone and microphone-amplifier circuits, functional circuit diagram (applies only to models with serial numbers from 1 through 747 on Order No. 18651-Phila-49).*

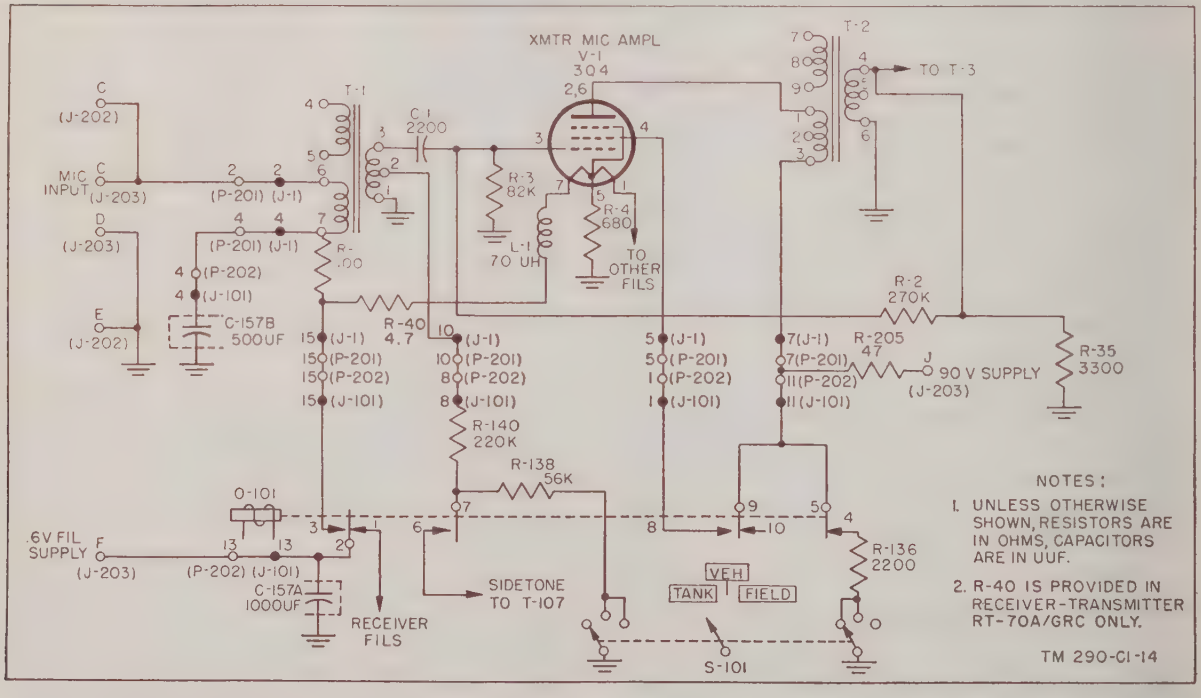



*Figure 12. Microphone and microphone-amplifier circuits, functional circuit diagram (applies to all models except those with serial numbers from 1 to 747 on Order No. 18651-Phila-49).*

necessary for tracking of the oscillator with the other tuned circuits of the transmitter and the receiver. These capacitors also provide temperature compensation at the low-frequency end of the oscillator tuning range. Alinement of the oscillator at the low end of its frequency range is accomplished by varying the inductance by means of the powdered iron dust core of coil L3. The HF end is alined by means of variable trimmer capacitor C4 connected across C10A. Exact calibration of the oscillator with the TENTH-MCS dial is accomplished by bending the segments of the slotted plates (par. 73*e*) mounted at the rear of the gang capacitor (fig. 6). For a particular setting of the tuning capacitor, selected during operation by means of the tuning knob on the front panel, the frequency generated by the oscillator is determined by the total instantaneous inductance of coils L3 and L2B. As explained in paragraph 21, since the inductance of L2B is made to vary in proportion to the amplitude and frequency of the AF output of the microphone amplifier, the total inductance of the resonant circuit also varies at the AF rate, and the frequency generated by the oscillator varies from nominal or center value, accordingly. The center frequency is set during alinement by adjustment of C4 and L3 and always is equal to the dial frequency minus 15 mc. The tuning range of the oscillator is between 32 and 43.4 mc.

*b. Colpitts Arrangement.* The arrangement of the oscillator into a Colpitts circuit is shown in figure 13. The grid is coupled to the resonant circuit by means of capacitor C8. Regenerative feedback from the plate-filament circuit necessary to sustain oscillation is provided through capacitor C14. Capacitors C11 and C14 constitute the conventional Colpitts voltage-dividing circuit. Capacitor C16 is a plate supply bypass. Its high value effectively places the plate at ground potential for RF. Capacitors C12 and C13 serve to place all portions of the filament at the same RF potential.

*c. Oscillator Output Connections.* A portion of the oscillator output, taken across capacitor C10A, is routed through the coupling circuit consisting of coil L4 and capacitor C53 to the input of receiver first mixer stage V9. Another portion of the oscillator output is taken from the junction of C12 and C13 and is routed through coupling capacitor C15 to the grid (pin 3) of transmitter mixer tube V4.

*d. Plate Supply.* Plate voltage for V2 is shunt-fed through coil L7 from the external 90-volt supply. The plate voltage connection for the oscillator is independent of the control circuit, since V2 must be operative during both receiving and transmitting periods. Capacitor C16 is a plate supply bypass capacitor. Its high value places the plate at ground potential for radio frequencies.

*e. Filament Circuit.*

(1) *Receiver-Transmitter RT-70/GRC.* (fig. 32). Filament current is supplied through inductor L5. Capacitors C13 and C12 bypass the filament for radio frequencies and also serve to maintain a uniform voltage across the filaments; i.e. to make the filaments an equipotential surface (like a cathode) for radio frequencies.

(2) *Receiver-Transmitter RT-70A/GRC.* The filament circuit of V2 is in parallel with the filament circuit of V4 (fig. 33). These two filaments are connected through voltage-dropping resistor R37 to the parallel arrangement of the filaments of V108 and V106. Filament current for V2 is supplied through the filaments of V108 and V106, terminals 19 of J101 and P202, terminals 14 of P201 and J1, voltage-dropping resistor R37, and isolating choke coil L5. Bypass capacitor C24 filters out RF picked up in filament circuit.

*f. Grid Bias.* Grid resistor R5 limits the grid current of the oscillator and provides self-bias for the operation of the tube.

*g. Mechanical Arrangement.* To obtain maximum stability of the oscillator under high humidity conditions, as many of the circuit elements as possible have been inclosed in a box identified as T3. The alinement controls for C4 and L3 are accessible through the cover.

## 21. Modulator

(fig. 13)

*a.* In general, frequency modulation causes the center or carrier frequency of the master oscillator of the transmitter to be shifted in frequency in accordance with the audio signals to be transmitted. The amplitude variations of the audio signals become changes in the frequency of the carrier, while the frequency of the audio signals becomes the rate with which the frequency of the carrier changes from its center value.

*b.* In Receiver-Transmitter RT–70(*)/GRC, this function is performed by modulator coil L2. This coil consists of two sections. One section of coil L2B is placed in series with main tuning coil L3

of 32- to 43.4-mc oscillator V2. The other section of coil L2A is placed across the secondary winding of the microphone amplifier output transformer T2. The inductance of L2B is made to vary at the rate of the audio signals appearing across the secondary winding of T2. The instantaneous inductance of L2B adds to that of L3 and the total inductance determines the frequency which the oscillator will generate for a given setting of tuning capacitor C10A.

*c.* To accomplish the result described in *b* above, advantage is taken of the principle that the inductance of the coil is determined by the permeability of its iron dust core. By varying the flux density in the iron core, the permeability of that core and, thereby, the inductance of the coil can be changed. Coil L2B has a small iron dust toroidal core on which are wound 2 turns of relatively heavy wire. This coil is placed in the air gap of the laminated iron core of the larger coil, L2A. A permanent magnet placed in the magnetic structure of L2A sets up a *fixed magnetic bias* for determining the flux density in and the permeability of the toroidal core (and thus the inductance) of L2B when no audio currents flow in coil L2A. This operating point sets the initial inductance of L2B so that, together with the inductance of L3, the oscillator is tuned to the center frequency (dial number minus 15) selected by the setting of C10A.

*d.* When AF current flows through the winding of L2A, the electromagnetic field set up by this current in the laminated iron core adds to, or subtracts from, the flux provided by the permanent magnet. This causes corresponding changes in the flux density in the toroidal core and causes its permeability to shift up or down along the permeability curve. The magnitude of such changes is proportional to the magnitude of the audio current in L2A. The rate with which flux density in the toroidal core changes is proportional to the frequency of the audio signal. The change in permeability of the toroidal core translates itself into a change in the inductance of L2B. The net effect is that the tuning of the oscillator and, consequently, the generated frequency changes in accordance with the instantaneous amplitude of the audio signal across L2A and the rate of change of the carrier frequency is proportional to the frequency of the audio signal.

## 22. Fixed 15-mc Transmitter Oscillator V3 (fig. 14)

*a. Rf Circuits.* Fixed 15-mc transmitter oscillator V3 uses a type 1L4 pentode tube in a 7.5-mc crystal-controlled electron-coupled oscillator. A 7.5-mc crystal connected between the control grid (pin 6) and ground establishes the oscillating frequency. The screen grid of the tube (pin 3) is

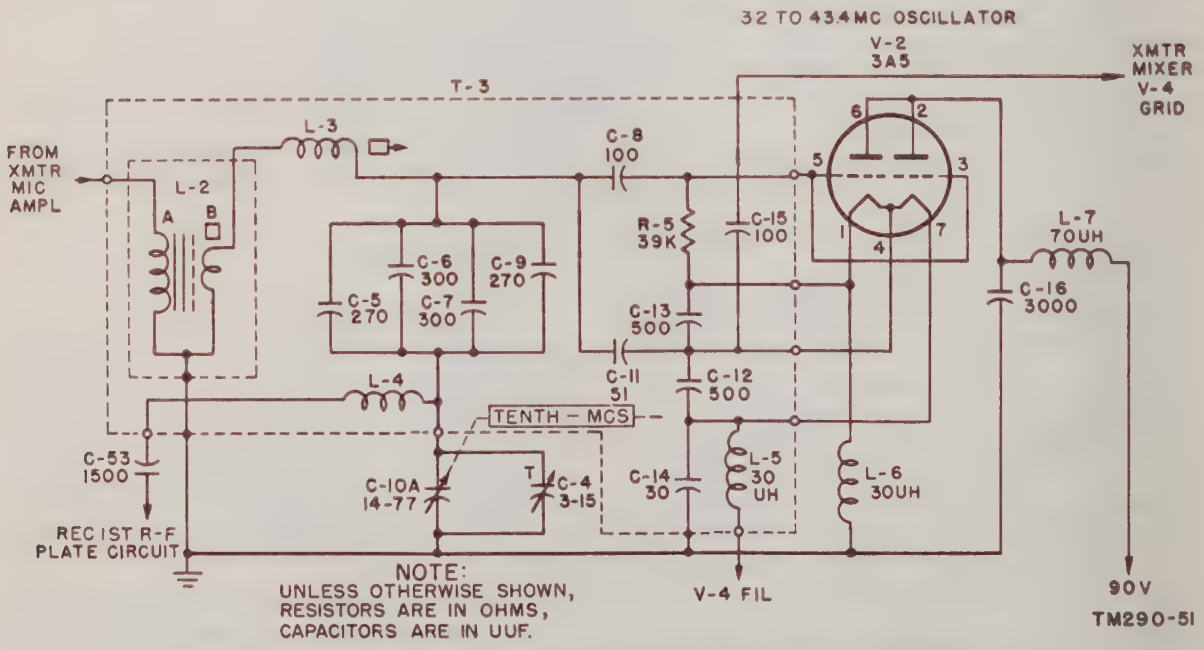
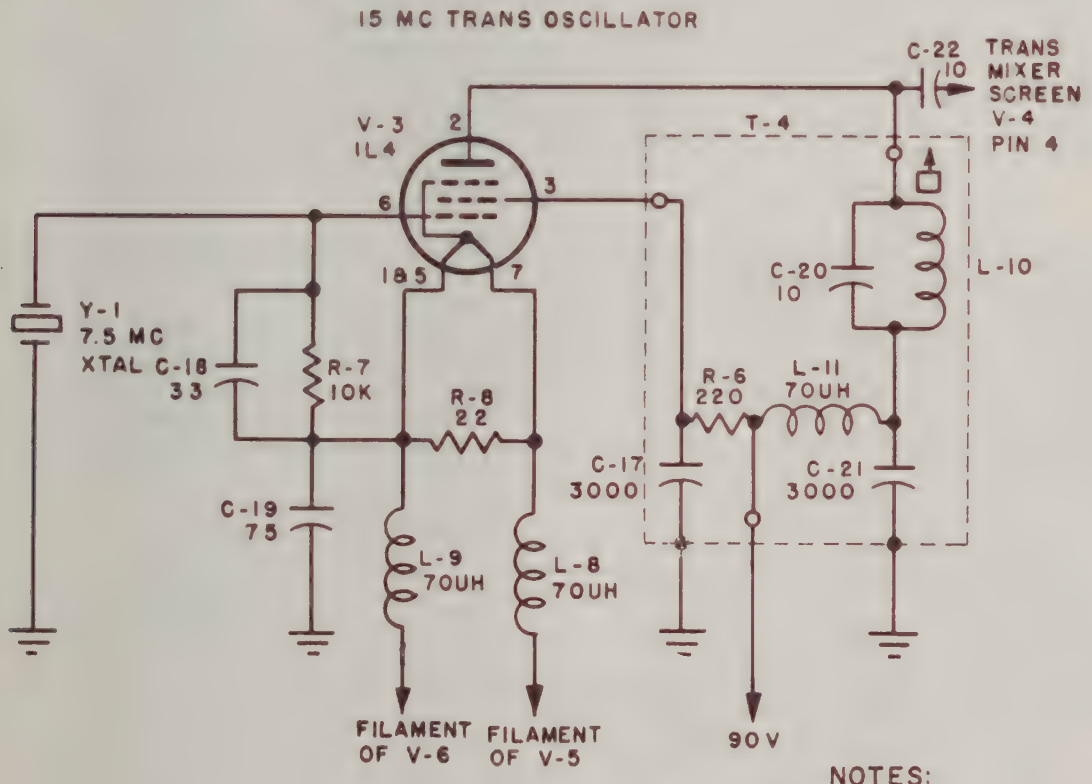



*Figure 13. Reactance modulator and 32- to 43.4-mc oscillator circuits, functional diagram.*

returned to the grid circuit through ground, by capacitor C17. Oscillatory feedback between the control grid and screen grid is established through the internal electrode capacitance of the tube. Capacitors C18 and C19 act as a voltage divider to establish the proper grid drive for the tube. The grid current is returned to filament by grid leak resistor R7. The plate circuit (pin 2) of the stage is tuned to 15 mc, the second harmonic of the oscillator frequency, by capacitor C20 and variable inductance L10. The plate and screen components of the crystal oscillator are assembled in a can identified as T4.

*b. Dc Circuits.* Plate voltage is applied through filter coil L11, which is bypassed to ground for RF by capacitor C21. Screen voltage is applied through decoupling resistor R6 which is bypassed by capacitor C17. In Receiver-Transmitter RT–70/GRC, filament voltage is applied through filter coils L8 and L9. Resistor R8 reduces filament current to the proper value (fig. 32). In Receiver-Transmitter RT–70A/GRC, resistor R8, shunted across the series arrangement of L9, the filament of V3, and L8, reduces filament current to the proper value (fig. 33).

*c. Output Circuits.* The second harmonic frequency voltage developed across the tuned-plate circuit is applied through coupling capacitor C22 to the screen grid (pin 4) of transmitter mixer stage V4.




NOTES:

1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. IN RECEIVER – TRANSMITTER RT-70A/GRC, FILAMENT CURRENT LIMITING RESISTOR R-8 IS 30 OHMS AND IS CONNECTED BETWEEN THE "FILAMENT OF V-6" AND "FILAMENT OF V-5" ENDS OF L-9 AND L-8.

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*Figure 14. 15-mc oscillator, functional diagram.*

## 23. Transmitter Mixer Circuit V4

*a. RF Circuits.* The transmitter mixer stage uses a type 3Q4 pentode tube, V4. The output of variable 32- to 43.4-mc oscillator V2 is coupled through capacitor C15 to the control grid (pin 3) of V4. Simultaneously, the 15-mc output of crystal oscillator V3 is coupled through capacitor C22 to the screen grid (pin 4) of the mixer tube. The tube combines the two signals to produce sum and difference frequencies. The sum frequencies are the desired transmission frequencies and correspond to the frequency setting of the dial on the front panel. These frequencies are selected by the parallel-resonant plate circuit consisting of L13, tuning capacitor C10B, and trimmer capacitor C27. Capacitor C26 is an isolation capacitor to keep dc voltage off C27. For tracking at the low-frequency end, the inductance of L13 is adjustable by means of the powdered iron slug of the coil. Adjustment of tracking at the high end of the band is accomplished by means of trimmer capacitor C27. The tuning range of the circuit is between 47 and 58.4 mc.

*b. Dc Circuits.* Plate voltage is applied through the filter circuit consisting of filter coil L14 and bypass capacitors C29 and C28. Although C28 is in the tank circuit, it has no effect on the tuning; the main purpose being to bypass RF to ground. Screen voltage is applied through voltage-dropping resistor R9. In Receiver-Transmitter RT-70/GRC, filament voltage is applied through coil L12. Resistors R11 and R12 limit the current flow through the filaments to the proper value. Capacitor C23 is a filament bypass capacitor. Capacitors C23, C24, and C25 place terminals 7, 1, and 5 of V4 at ground potential. In Receiver-Transmitter RT–70A/GRC (fig. 33), filament voltage is supplied from the 6.3-volt supply through the parallel arrangement of V106 and V108, terminals 19 of connectors J101 and P202, terminals 14 of connectors P201 and J1, voltage-dropping resistor R37, which is bypassed for RF through bypass capacitor C24, and isolating choke coil L12. The voltage appearing at the junction of R37 and L12 also is applied to the filament circuit of V2, which is in parallel with that of V4. The center tap of the filament of V4 is returned to ground through filament current limiting resistor R36, which is bypassed for RF by C25. This arrangement, together with filament bypass capacitor C23, keeps both halves of the V4 filament at RF ground potential. This establishes the filament as an equipotential (cathode) surface and insures linear operation of the mixer stage. The control grid is returned to the filament by grid resistor R10.

*c. Output Circuit.* The sum frequency selected by the tuned-plate circuit is coupled to transmitter driver stage V5 through capacitor C30. The plate circuit components, including tuning coil L13, trimmer capacitor C27, and components of the plate supply filter are mounted in a can identified as T5. The adjustment controls for L13 and C27 are available through the side walls of this can.

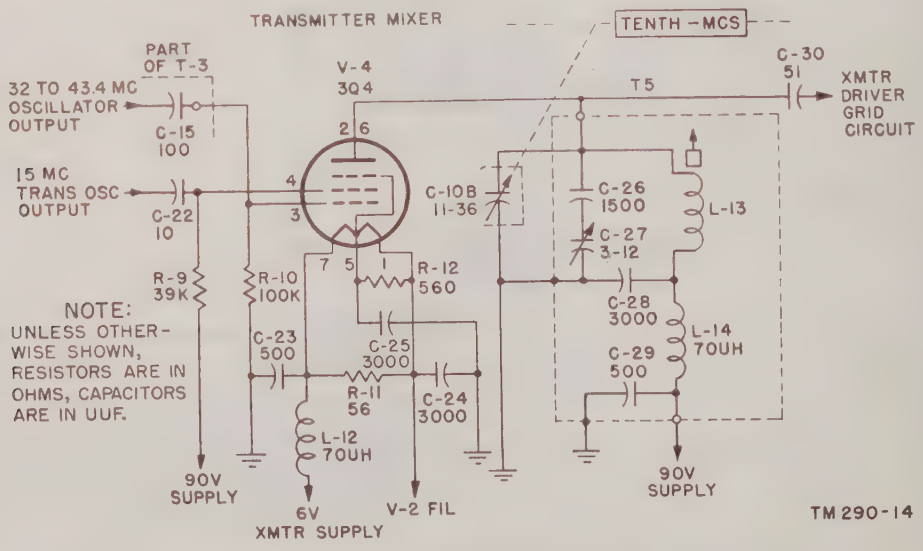



*Figure 15. Receiver-Transmitter RT–70/GRC, transmitter mixer circuit, functional diagram.*

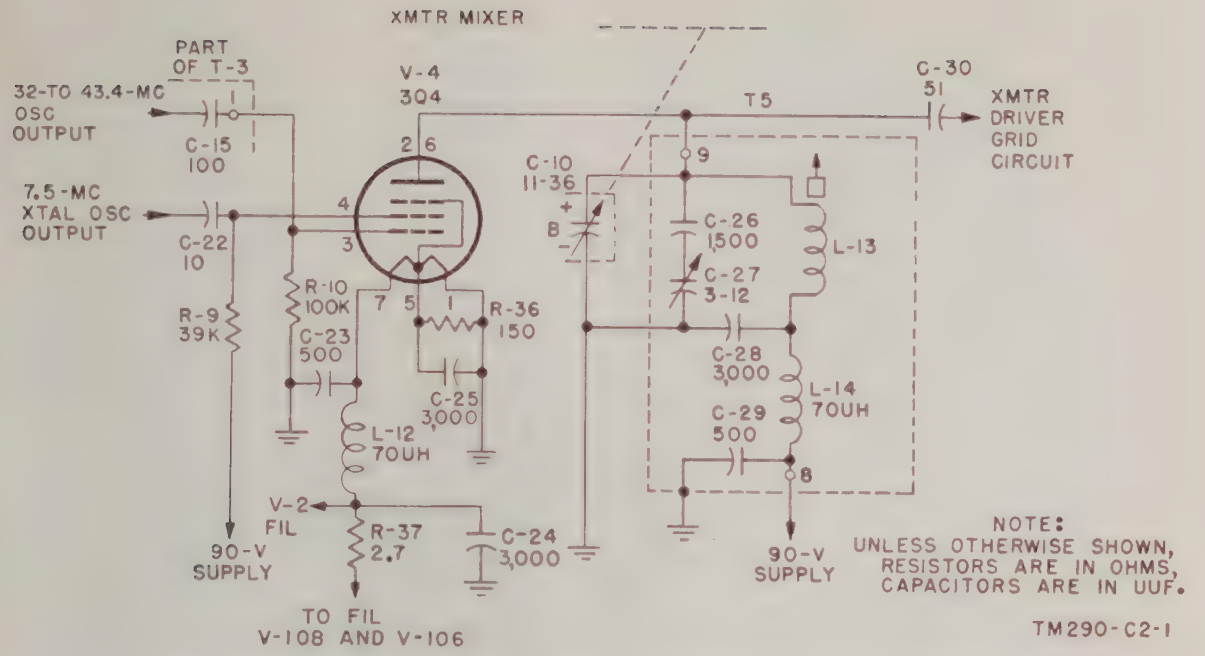



*Figure 16. Receiver-Transmitter RT-70A/GRC, transmitter mixer circuit, functional diagram.*

## 24. Transmitter Driver V5
(fig. 17)

*a. RF Circuits.* The transmitter driver stage uses a type 3Q4 pentode tube, V5. The output of the mixer stage is coupled through capacitor C30 to the grid (pin 3) of V5. Grid-leak bias is developed by C30 and series grid resistors R13 and R14. Capacitor C30 couples the signal from the mixer stage. Resistor R14 provides a means for grid drive measurement. The measuring point (E1) is a standoff insulator wired in at the junction of R13 and R14. The voltage across R14 may be measured from test point E1 to pin 7 of V5. The plate circuit of V5 is tuned to the dial frequency by the resonant circuit composed of coil L16A and tuuing capacitor C10C. Tracking may be adjusted by means of the variable powdered iron core of coil L16A and also by means of trimmer capacitor C34 connected across the tuning capacitor section. Capacitor C33 is an isolation capacitor to keep dc voltage from C34. The output of the transmitter driver is coupled to the transmitter power amplifier stage through capacitor C37.

*b. Dc Circuits.* Plate and screen voltages are supplied from the 90-volt source through resistors R16 and R15. These are bypassed for RF by capacitors C36 and C32. In Receiver-Transmitter RT-70/GRC, the filament circuits are bypassed to ground by capacitor C31. In Receiver-Transmitter RT-70A/GRC, the filament of V5 is fed from the 6.3-volt supply through normally open contacts 2 and 3 of relay O 101, terminals 15 of connectors J101, P202, P201, and J1, and through voltage-dropping resistor R40 (fig. 33).

*c. Neutralizing Circuit.* The series arrangement fof coil L16B and variable capacitor C35, connected between the grid (pin 3) of V5 and the junction of L16B and R16, is a neutralizing or negative voltage feedback circuit serving to balance out the grid-to-plate capacitance of the tube and thus to cancel out any tendency of the tube to break into oscillations. This arrangement serves to provide for stable operation of this relatively high power stage. Coil L16B is closely coupled to tuning inductance L16A, being interwound with it on a common form.

## 25. Transmitter Power Amplifier V6
(fig. 17)

*a. RF Circuits.* The output stage or power amplifier of the transmitter uses a type 3B4 tube, V6. Grid drive is obtained from the output of the driver stage through coupling capacitor C37. The grid circuit is returned to ground through resistor R17 in series with measuring resistor R18. Grid leak developed across these resistors furnishes bias for the operation of the tube. Resistor R18 provides

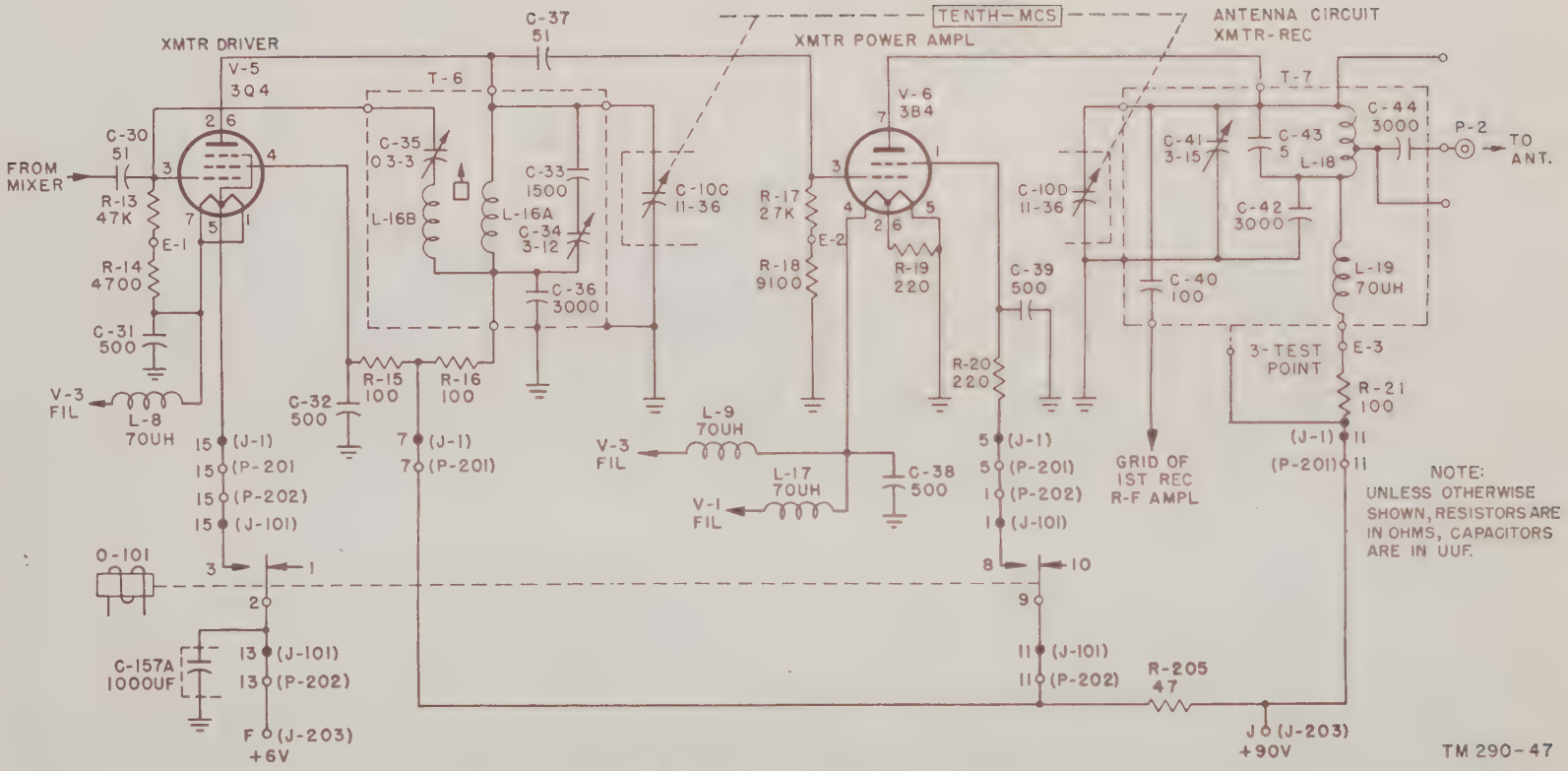



*Figure 17. Transmitter driver and power amplifier circuits, functional diagram.*

a means for grid drive measurement. Measurement is made from standoff insulator E2, at the junction of R17 and R18, to chassis. The plate (pin 7) of V6 is connected directly to the tuned antenna circuit which acts as the plate load impedance. This circuit is tuned to a frequency within the range of 47 to 58.4 mc depending on the dial setting. The circuit includes coil L18, capacitor C43, tuning capacitor C10D, and trimmer capacitor C41.

*b. Dc Circuits.* Plate voltage is fed to the amplifier tube through filter coil L19 and antenna tuning coil L18 from the 90-volt supply. Capacitor C42 bypasses the plate supply for RF. Screen voltage is fed from the 90-volt supply through decoupling resistor R205 and normally open contacts 8–9 of relay O 101 and through decoupling resistor R20, which is bypassed by capacitor C39. The filament supply circuit includes filter coil L17 and RF bypass capacitor C38. Resistor R19 limits the current flow in the filaments of the tube to the proper value.

*c. Measurements.* Resistor R21 in series with plate supply coil L19 provides a means for measuring the plate current for the power amplifier stage. Measurement is made between terminals 1 and 3 on the case of T7. This is terminal 12 of connector J1 and P201. Measuring point E2 at the junction of R17 and R18 provides means of determining grid drive for V6.

## 26. Antenna Circuit

(fig. 18)

The antenna circuit is common to both the transmitter and receiver. It includes tuning coil L18, capacitor C43, trimmer capacitor C41, and tuning capacitor C10D. The antenna proper is brought to the transmitter and receiver circuits through a plug-in connection into coaxial ANT connector (J201) on the front panel of the set. A wire terminated in female pin connector P2 provides the path from the ANT connector on the rear of the panel through coupling capacitor C44 to antenna circuit T7 on the RF chassis. The impedance of the antenna is matched to the antenna circuit by bringing the connecting wire to a tap on tuning inductance L18. The antenna circuit is used as the tuned-plate load for transmitter power amplifier V6, and is also coupled to the grid of receiver first RF amplifier V8 through coupling capacitor C40. Since the filaments of transmitter power amplifier V6 and receiver RF amplifier V8 are alternately turned on and off by control relay O 101, there is no interference from the transmitter into the receiver even though the two are connected to the same point in the circuit. For a detailed description of the control circuits, see paragraph 36. For alinement purposes, the inductance of L18 is adjustable by spreading the turns with an insulated tool. Access to the coil is obtained through a hole on the RF coil compartment located on the wiring side of the RF chassis. Trimmer capacitor C41 is used for tuning adjustment at the high end of the band. It is adjusted for minimum noise in the receiver. Since the operating frequencies of the transmitter and of the receiver are always the same, once the antenna circuit has been adjusted for one, the adjustment will hold for the other. The components of the antenna circuit proper and power amplifier plate supply filter components L19 and C42 are mounted in a compartment (identified as T7) of the RF coil assembly.

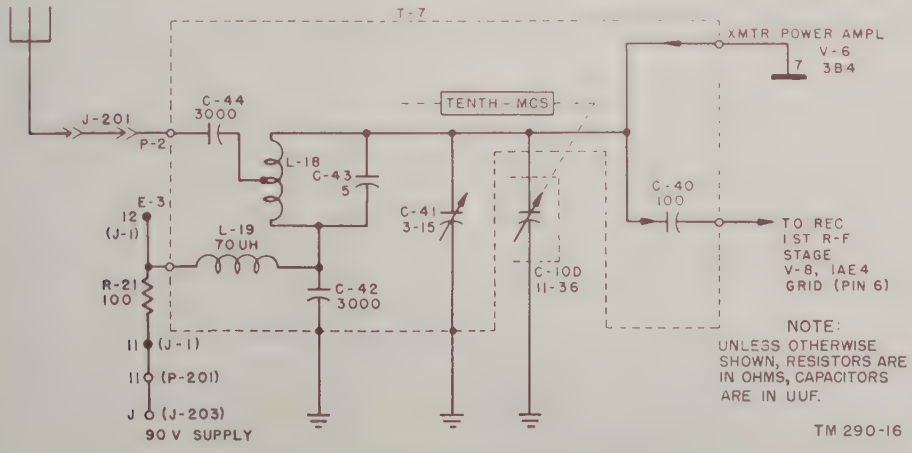



*Figure 18. Antenna circuit, functional diagram.*

## 27. Receiver First RF Amplifier V8
(fig. 19)

*a.* Receiver RF stage V8 uses a type 1AE4 pentode tube. This tube is particularly suitable because of the high signal-to-noise ratio obtainable with it. Capacitor C40 couples the antenna circuit to the grid (pin 6) of V8. The output of calibrate oscillator V7 also is coupled to pin 6 of V8 through capacitor C47. Normally, however, the calibrate oscillator is disabled by test switch S202 on the front panel. The calibrate oscillator is described in paragraph 38.

*b.* The control grid of V8 is returned to ground through R24 and R34. When a signal is being received, the dc component of grid current through these two resistors develops part of the bias voltage for this tube. Additional current is made to flow through R34 through a connection from the grid (pin 6) of first limiter V104 and voltage-dropping resistor R142. This increases the voltage drop across R34 and increases the bias voltage at the grid of V8. The bias voltage developed at the grid of V104 varies with the strength of signal picked up by the antenna, and also varies from one unit to another depending on the gain of the RF and IF amplifier stages in each unit. In either event, a greater negative bias voltage is developed at this grid when relatively strong signals reach it. This greater bias voltage produces a greater current flow through R34 and thus increases the bias voltage at the grid of V8. An increase in the negative bias at V8 lowers the gain of this tube and thus compensates against increased signals being applied to first limiter V104. This action is a type of automatic gain control (agc) which tends to keep the signal that reaches the first limiter grid at a constant level despite differences in strength of signal received at the antenna, or differences in gain between individual sets.

*c.* The plate circuit (pin 2) includes the parallel-resonant circuit composed of L23, gang tuning capacitor C10E, trimmer capacitor C56, and capacitor C55. Trimmer capacitor C56 and the powdered iron core of L23 are used to adjust the alinement of the stage at the high and low ends of the band. Coil L23 is returned to ground for RF through bypass capacitor C57.

*d.* Plate voltage is supplied through voltage-dropping resistor R25, which is bypassed by capacitor C57. Screen (pin 3) voltage is filtered by capacitor C52. These voltages are obtained from the 90-volt supply through decoupling resistor R205 and are not controlled by the relay contacts. Filament voltage is obtained over normally closed contacts 1 and 2 of relay O 101 (par. 42).

*e.* The output of V8 is coupled through capacitor C54 to the grid (pin 6) of receiver first mixer tube V9.

## 28. Receiver First Mixer V9
(fig. 19)

*a.* The first mixer stage uses a type 1U4 pentode tube V9. The tube is operated as a triode, with the plate (pin 2) and the screen grid (pin 3) connected together. The signal voltage from the first receiver RF amplifier and the heterodyne frequency voltage from variable 32- to 43.4-mc oscillator V2, are both injected to the grid (pin 6) of the tube through coupling capacitor C54. The signal voltage is taken from the plate of V8. The oscillator output, taken at the junction of variable capacitor C10A and padder capacitors C5, C6, C7, and C9, is routed through the series arrangement of inductor L4 and capacitor C53.

*b.* The grid (pin 6) is returned to filament through grid leak resistor R26. Measuring resistor R27, in series with R26, provides means for measuring the voltages applied to the grid. Measurement is made between test point E4 and pin 1 of V9. Capacitor C51 in the filament circuit provides RF ground return for the grid circuit.

*c.* The incoming signal and the frequency generated by the variable oscillator are mixed in V9 to produce sum and difference frequencies, as well as harmonics of these frequencies. The tuned-plate circuit is adjusted to resonance at the difference frequency; namely, the incoming signal frequency minus the variable oscillator frequency. Since the variable oscillator frequency is always 15 mc lower than the frequency to which the receiver is tuned, the difference frequencies selected by the tuned circuit is in a band centered about 15 mc. This is the first IF of the receiver. All other frequencies produced in the mixer stage are effectively rejected by the high Q of the tuned circuit. The output of the mixer stage is coupled to the grid circuit of first IF amplifier stage V10 through capacitor C60.

*d.* The plate circuit is tuned to resonance at 15 mc by the parallel-resonant circuit composed of fixed capacitor C58 and tuning coil L25. The inductance of L25 and the alinement of the stage is adjustable by means of the powdered iron slug of the coil.

*e.* Plate voltage is supplied through voltage-dropping resistor R28, which is bypassed to ground by capacitor C59. In Receiver-Transmitter RT–70/

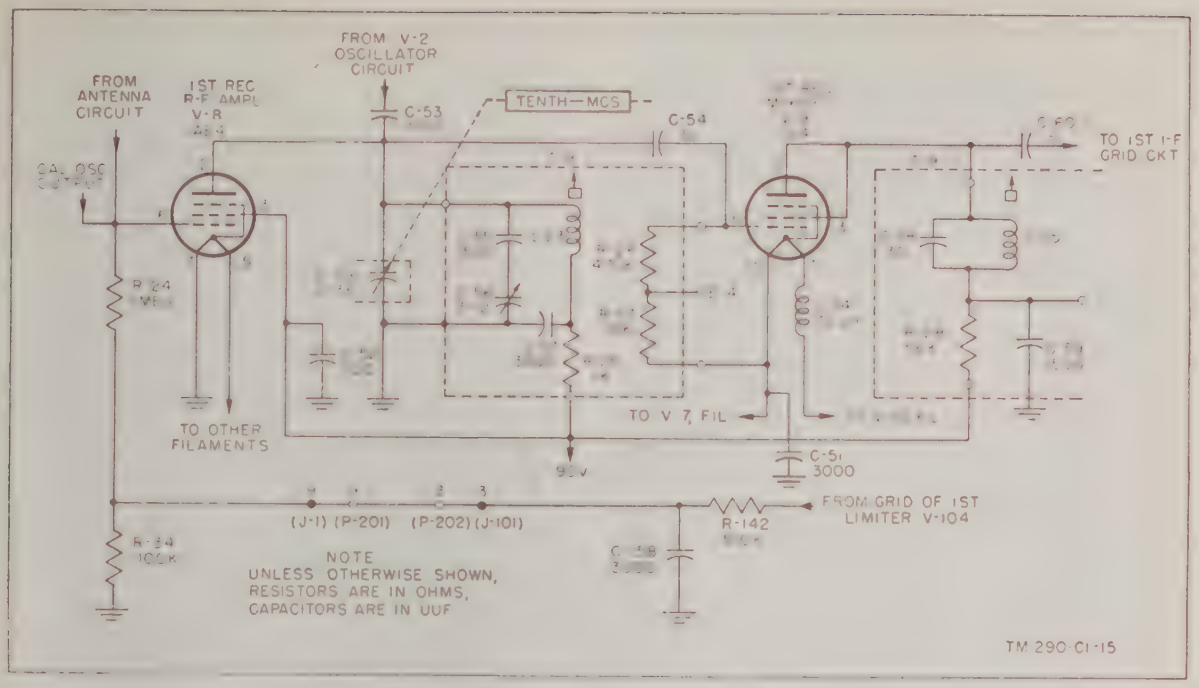



*Figure 19. First RF amplifier and first mixer, functional diagram.*

GRC, the filament circuit includes isolating choke coils L24, L22, and bypass capacitor C51. In Receiver-Transmitter RT-70A/GRC, the filament circuit of V9 includes the series arrangement of isolating choke L24 (fig. 34), the filament of V9, voltage-dropping resistor R38, and isolating choke L22. RF currents are bypassed to ground through capacitors C51 and C61 (fig. 33). The filament voltage of this tube, as well as for other tubes of the receiver, is applied through contacts of the control relay and is disconnected when the set is in the transmitting condition. The control circuit is described in paragraph 36.

## 29. 15-mc IF Amplifiers
(fig. 20)

*a. General.* The 15-mc output of the receiver first mixer is coupled through capacitor C60 to the grid of the first stage of three-stage IF amplifier V10, V11, and V101. The first two stages are located on the RF chassis. The plate circuit components of second stage V11 and third stage V101 are located on the IF chassis. Wire, fitted with pin plug P1, establishes the connection between the two chassis. Each stage uses a type 1U4 pentode tube. The plate circuit of each is permeability tuned, by means of a powdered iron slug in the tuning coil, to pass a band of frequencies centered about 15 mc. The bandwidth is determined by the total Q of the circuit. The output of the third stage is coupled to second receiver mixer and oscillator V102 through capacitor C108.

*b. IF Amplifier Stage V10,* The grid (pin 6) of first 15-mc IF amplifier stage V10 is returned to the filament by current limiting grid resistor R29 and returned to ground for intermediate frequencies through filament bypass capacitor C61. The plate circuit is tuned to resonance at 15 mc by a single tuned circuit composed of fixed capacitors C62 and C66 (figs. 53 and 54) and adjustable coil L27. The inductance of L27 is adjustable by means of a powdered iron core. Coupling capacitor C64 applies the amplified output of V10 to the grid of second if stage V11. Plate and screen potentials are applied to V10 through voltage-dropping and filter resistor R30, which is bypassed to ground by capacitor C63. Filament voltage is applied over normally closed contacts 1 and 2 of control relay O 101 and through isolating choke coil L26.

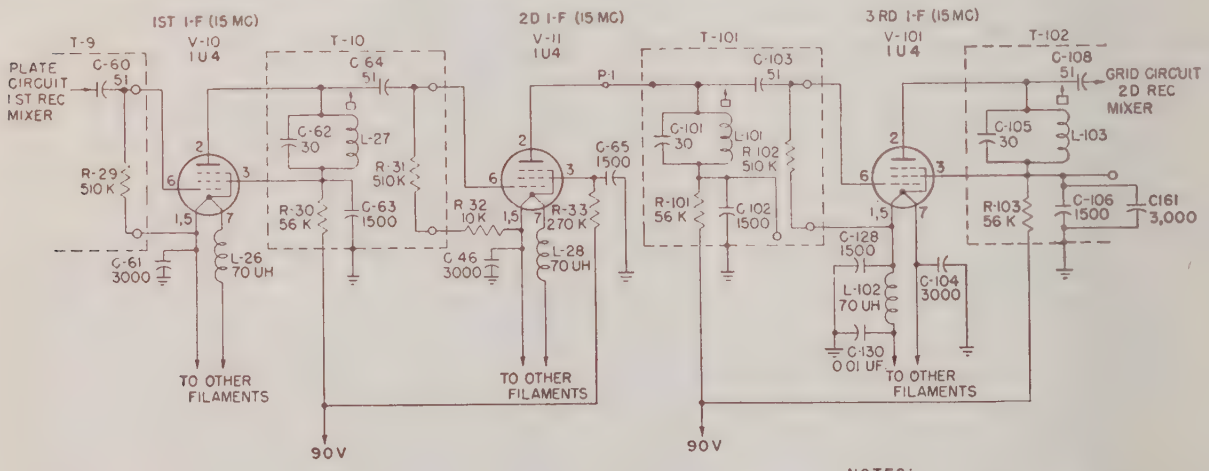
*c. IF Amplifier Stage V11.* Second IF amplifier stage V11 is very similar in circuit arrangement to first stage V10 (*b* above). The grid is returned to filament through grid resistor R31 in series with measuring resistor R32. Ground return for IF is established through filament bypass capacitor C46.

The voltage measured across this resistor (between pin 1 of T10 and chassis) is an indication of the signal voltage applied to the grid of V11. Connection between the plate, pin 2, of V11 and tuning unit T101 is made through plug-in connection P1 between the RF and IF chassis (*a* above). The permeability tuned-plate circuit, composed of capacitors C101 and C160 (figs. 53 and 54) and inductor L101, is tuned to resonance at 15 mc. Coupling capacitor C103 applies the amplified output of V11 to grid of third IF amplifier V101. Plate voltage is applied to V11 through voltage-dropping resistor R101, which is bypassed to ground by capacitor C102. In all models except those with serial numbers from 1 through 3111; 6371 through 7158; and 14232 through 14325, C159, .01 μf, is added across C102 to provide the increased filtering necessary to prevent spurious oscillations. Screen voltage for V11 is applied through voltage-dropping resistor R33 which is bypassed by capacitor C65. Capacitor C46 provides the RF ground return for the filament and the grid circuit of V11. Choke coil L28 isolates the filament of V11 from the filament supply circuit.

*d. IF Amplifier Stage V101.* Third IF amplifier stage V101 is identical in circuit arrangement with first stage V10. Current limiting resistor R102 in T101 returns the grid to filament. IF ground return is established through filament bypass capacitor C128. The tuned-plate circuit, composed of capacitor C105 and inductor L103, is tuned to resonance at 15 mc. Coupling capacitor C108 applies the amplified output of V101 to the grid of the second receiver mixer and oscillator stage V102. Plate and screen potentials are applied to V101 through voltage-dropping resistor R103, which is bypassed to ground by capacitor C106. Filament voltage supplied through isolating choke L102 is bypassed by capacitors C130 and C128. In Receiver-Transmitter RT–70A/GRC, choke coil L102 is replaced by voltage-dropping resistor R145 (fig. 48) which is bypassed by capacitors C130 and C128. In models of Receiver-Transmitter RT–70/GRC on Order No. 2884–Phila–52 with serial numbers from 1 through 888, and in models of Receiver-Transmitter RT–70A/GRC, capacitor C161, added across C106, provides for additional decoupling for the plate and screen supply for V101 and prevents IF regeneration.

## 30. Receiver Second Mixer and Oscillator (fig. 21)

*a.* Tube V102, a type 1R5 pentagrid converter, serves the dual purpose of crystal oscillator and receiver second mixer. The frequency generated by the oscillator is such that in beating with the 15-mc IF band, a lower IF band centered about 1.4 mc is produced.




NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. IN RECEIVER-TRANSMITTER RT-70A/GRC, RESISTOR R145 (13 OHMS) REPLACES CHOKE COIL L102.
3. CAPACITOR C161 IS ADDED IN MODELS OBTAINED ON ORDER NO. 2884-PHILA-52, SERIAL NOS. 1 TO 888 AND ON ALL MODELS OF RADIO-TRANSMITTER RT-70A/GRC.

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*Figure 20. 15-mc IF amplifiers, functional diagram.*

*b.* The fixed crystal oscillator is a conventional Pierce type circuit, using the first grid (pin 4) as the oscillator grid and the screen grid (pin 3) as the oscillator plate. Quartz crystal Y101 is connected between these two electrodes. Oscillatory feedback is established through capacitors C109 and C111. Resistor R105 places the grid of the oscillator at approximately −2.25 volts with respect to its filament by connection to pins 1 and 5 of V103. (Pins 1 and 5 are at a potential which is about 2.25 volts lower than the average voltage of the filament of V102.) The oscillator generates a fundamental frequency of 6.8 mc and a number of harmonics of that frequency.

*c.* The mixer circuit includes the signal grid (pin 6) and the plate (pin 2) of V102. The 15-mc signal from the output of V101 is applied to the grid (pin 6) while the crystal oscillator output is, in effect, injected into the mixer circuit at the screen grid (pin 3). Since the oscillator output is 6.8 mc plus the harmonics of that frequency, the resultant beat frequencies include difference components between the signal frequencies and each of the oscillator output frequencies. The difference frequencies produced by mixing the 15-mc signal with the second harmonic output of the oscillator (13.6 mc) are selected by the double tuned-plate circuit of V102. The band of frequencies thus selected is centered about 1.4 mc. The double tuned-plate circuit includes the parallel arrangement of primary coil L105, fixed capacitor C112, and damping resistor R106. Resistor R106 loads the tuned circuit to broaden the frequency response enough to include the entire IF band. The 1.5-mc signal voltage developed across the tuned-plate circuit is coupled to the input of the fourth IF stage by induction between primary coil L105 and secondary coil L106. The latter coil is the inductive portion of the tuned-grid circuit of fourth IF amplifier stage V103. The tuned secondary circuit includes coil L106 and fixed capacitor C113. The primary and secondary coils of this tuned circuit and the tuned circuit of the following if amplifier stages are overcoupled. The resultant IF characteristic therefore has a double peak and a dip between the peaks. The purpose of this arrangement is to provide a broad overall IF response characteristic. Primary and secondary coils L105 and L106 are slug-tuned by means of powdered iron cores. Coupling capacitor C114 applies the signal voltage developed across the tuned secondary circuit to the grid of the fourth IF amplifier stage. The grid (pin 6) of the mixer circuit is returned to filament by resistor R104 and bypassed for RF by capacitor C107.

*d.* Plate voltage for V102 is supplied through voltage-dropping resistor R108 which is bypassed by capacitor C110. Screen voltage is supplied through R108 and choke coil L107, which also acts as the load for the crystal oscillator. Filament voltage is applied through isolating choke L104. Capacitors C107 and C104 serve as filament bypass capacitors.

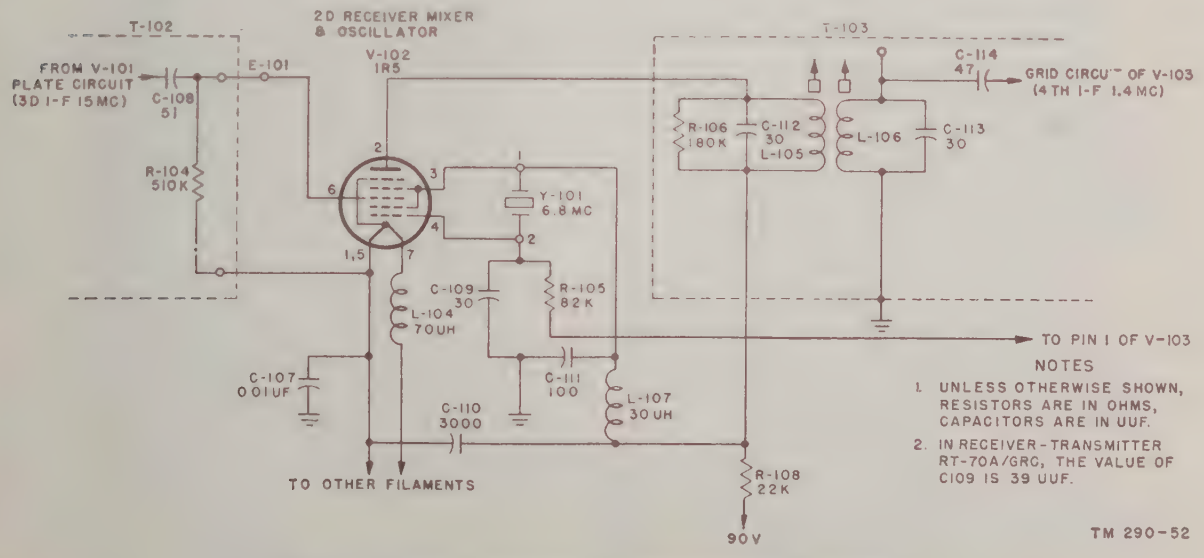


*Figure 21. Receiver second mixer and oscillator, functional diagram.*

## 31. 1.4-mc Amplifier and Limiters
(fig. 22)

*a. Fourth IF Amplifier V103.* The 1.4-mc IF band is selected from the output of receiver second mixer V102 by the double-tuned circuit in tuning unit T103 (par. 30), and is coupled through capacitor C114 to the grid (pin 6) of fourth IF amplifier stage V103.

(1) Coupling capacitor C114 has the additional function of blocking any dc which may be flowing in the filament-to-grid circuit of V103 from tuned secondary coil L106 of T103. The dc return path for the grid is established through grid leak resistor R109 in series with measuring resistor R107, which is bypassed for signal frequencies by capacitor C115. The grid leak resistor has the additional function of limiting grid current flow for very strong signals.

(2) Test point E102, provided at the junction of R109 and the grid (pin 6) of V103, permits measurement of the ac signal voltage and of the dc bias voltage applied to the tube. Ac measurements from this point to ground give indication of the driving voltage provided by the signal, since C115 effectively returns the grid to ground for signal frequencies. Measurement across R107 (between pins 4 and 3 of T103) gives indication of the dc bias voltage.

(3) The double tuned-plate circuit of V103 (tuned plate of V103 and tuned grid of V104) is identical in circuit arrangement and component values with T103 (par. 30) for V102. The circuit is tuned to resonance at 1.4 mc. The primary circuit includes coil L109, fixed tuning capacitor C118, and damping resistor R110. The secondary circuit includes coil L110 and fixed tuning capacitor C119. As in the case of T103, double tuning provides a high degree of IF selectivity while maintaining the desired bandwidth. The bandwidth is determined by overcoupling between the primary and secondary coils. In addition, the resistive load provided by R110 flattens out the frequency response of the tuned circuit. The 80-kc band centered about 1.4 mc selected by the tuned circuit is coupled to the input of first limiter stage V104 through capacitor C120.

(4) Plate and screen voltages for V103 are applied through voltage-dropping resistor R111, which is bypassed by filter capacitor C117. Filament voltage is fed through isolating coil L108. Capacitors C116 and C107 bypass the filament circuit to ground. Capacitor C116 effectively places the junction of R107 and filament (pin 1) at ground potential for signal frequencies.

*b. First Limiter V104.* The output of the fourth IF amplifier stage, selected by the tuned circuits of T104, is coupled through capacitor C120 to the grid circuit of first limiter stage V104, a type 1U4 pentode tube. The circuit arrangement and the values of the components in the stage are identical with those of the fourth IF stage. The stage has the dual function, however, of not only providing further amplification to the signal band centered about 1.4 mc, but also to provide limiting action for strong signals so as to eliminate any amplitude variations which may have been superimposed upon strong signals. Limiting action of this and the following stage is described in *d* below.

(1) The series arrangement of grid leak resistor R113 and measuring resistor R112 provides the dc return path for the grid to the filament of the tube. The grid return path to ground for signal frequencies is established through bypass capacitor C121, which also bypasses measuring resistor R112 to ground for signal voltages. The measuring point (E103) is provided at the junction of R113 and the grid (pin 6) of the tube.

(2) A portion of the dc voltage appearing in the grid circuit of V104 as a result of grid circuit rectification of signal or noise voltages is coupled through R130 to the grid circuit of squelch oscillator tube V107. The action of the squelch circuit is described in paragraph 35. Capacitor C147 places one end of R130 at ground potential to RF voltages. Also, a portion of the negative dc voltage appearing in the grid circuit of V104 as a result of grid current rectification of signal and noise voltages, is fed back through voltage-dropping resistor R142, terminals 3 of J101 and P202, and terminals 9 of P201 and J1, to the grid circuit of V8, where it is applied as a bias voltage across R34. This bias voltage tends to reduce the gain of V8 when very

strong signals enter the receiver, or when the gain of the particular receiver is high (par. 27*b*).

(3) A double-tuned circuit tunes the plate of V104 and the grid of V105 to resonance at 1.4 mc. The primary tuned circuit includes coil L112, fixed tuning capacitor C124, and damping resistor R114. The secondary tuned circuit (grid) includes coil L113 and fixed tuning capacitor C125.

(4) Plate and screen potentials are applied through voltage-dropping resistor R115, which is bypassed by capacitor C123. Filament voltage is supplied through isolating choke L111. The filament is bypassed to ground by capacitors C122 and C116.

(5) The amplified and limited output of this stage is selected by tuning unit T105 and is coupled by capacitor C126 in that unit to the grid circuit of second limiter stage V105. The bandwidth thus selected is again centered about 1.4 mc. The limiting action provided by this and the following stage is described in *d* below. In Receiver-Transmitter RT–70A/GRC, current limiting resistor R127 (680 ohms) is connected between pin 7 of V104 and chassis (fig. 54).

*c. Second Limiter Stage V105.*

(1) Second limiter stage V105 uses a type 1L4 pentode tube. This tube is used to obtain sufficient signal voltage to operate the discriminator circuit which follows the second limiter stage. The grid circuit return path includes grid leak resistor R119 and measuring resistor R116, which is bypassed to ground for signal frequencies by capacitor C127. For measurement of RF grid drive, the junction of R119 and the grid (pin 6) of V105 is brought to measuring point E104. Measuring point E105 is used to measure dc grid voltage as an indication of grid drive.

(2) The plate circuit components of the second limiter stage are assembled in tuning unit T106. The primary circuit includes coil L115 and fixed tuning capacitor C134. No damping resist9r is provided. The secondary tuned circuit includes two balanced coils L116 and L117 shunted by the series arrangement of capacitors C135 and C136. Both the primary and the secondary circuits are tuned to resonance at 1.4 mc and the coupling between them is such that a band of frequencies centered about 1.4 mc is selected. The secondary circuit is a portion of the discriminator circuit described in paragraph 32.

(3) Plate and screen voltage for the second limiter tube is supplied through decoupling resistor R120, which is bypassed by capacitor C132. The filament circuit includes isolating c9il L114. Capacitor C122 bypasses the filament circuit for signal frequencies. In Receiver-Transmitter RT–70A/GRC, current limiting resistor R144 (470 ohms) is connected between pin 7 of V105 and chassis (fig. 33).

(4) Signal voltages developed across the primary tuned circuit are applied over two paths to the secondary tuned circuit, namely the discriminator. One path is established by inductive coupling between primary coil L115 and secondary coils L116 and L117. The other path is a direct connection from the plate (pin 2) of V105 to the center tap between capacitors C135 and C136. The purpose of this arrangement is described in paragraph 32.

*d. Limiting Action.* The first and second limiter stages have the dual functions of amplifying the 1.4-mc band of frequencies and of eliminating or limiting any amplitude variations.

(1) Proper operation of the discriminator circuit requires that the applied signal be free from amplitude variations due to bursts of noise and static or other causes, and that for wide variations in the strength of incoming signals, the average signal voltage applied to the discriminator input circuit remain fairly constant. Circuit design of the 1.4-mc IF amplifier and limiter stages is such that both of these functions are possible.

(2) When the signal voltage appearing across the grid circuit of any one of the three stages described above (V103, V104, and V105) exceeds a certain value, an increase in grid current causes limiting action or cutting off of signal peaks for one-half cycle of the signal voltage, while plate current saturation causes similar limiting action for the other half cycle of the signal voltage. In this manner, limiting of

amplitude variations is accomplished in both the grid and the plate circuits. When the average signal level is higher than that necessary to produce the required voltage across the discriminator input, the grid current is increased to the point where grid current rectification occurs. The dc grid current then flows through the associated grid leak resistor and develops a voltage across it which is negative at the grid (pin 6) of the tube. The negative voltage tends to bias the tube toward cutoff, thereby reducing the gain of the stage accordingly.

(3) While inherently all three stages, fourth IF amplifier V103 and first and second limiters V104 and V105, are capable of providing the action described above, the gain layout of the receiver is such that the signal voltage levels across the grid circuit of the fourth IF amplifier stage are normally not high enough to start limiting action there. Limiting action normally is confined to the first and second limiter stages.

(4) When the receiver is in standby condition and no signal is being received, the noise voltages in the antenna and the internal noises in the RF stage (inherent in any high gain circuit) are amplified by the several receiver stages. The amplification is sufficient to provide a voltage across the input of second limiter V105 to cause limiting action and grid current rectification to take place. Grid current rectification causes a reduction in the gain of that stage. Thus, under no-signal conditions, that stage operates at reduced gain.

(5) When a signal having the strength equivalent to the threshold of sensitivity of the receiver enters the antenna circuit, the voltage across the input to first limiter V104 is raised to the point where the noise voltages (which normally are superimposed upon the incoming signal as amplitude-modulation (AM)) are cut off by plate current saturation and by an increase in the grid current flow in the first limiter stage. This limiting action then is supplemented by the limiting action of the second limiter stage.

(6) The following is a summary of the limiting action described above. The first and second limiter stages function to eliminate any amplitude variations in incoming signal. Such amplitude variations represent noise and are, therefore, undesirable. It is necessary for the proper functioning of the discriminator circuit that the signal applied to it be approximately uniform in level regardless of the strength of the incoming signal. The gain of the receiver is sufficient to raise the level of the random noise to a value necessary to overload tube V105, the second limiter stage. Grid current flowing through resistor R119 in the grid circuit of that tube biases the tube toward the cutoff region and reduces the gain of the stage. Thus, the receiver operates at reduced gain due to the limiting action which takes place in tube V105. When a signal is received, tube V104 tends to overload and, therefore, limits its output in a similar fashion. This limiting in output of V104 is translated in terms of a fixed negative bias on the grid of V105. This tends to hold the gain of V105 constant, and thus prevent the output of that tube from falling off excessively due to overloading on strong signals. Therefore, for weak signals, the gain of V105 and V104 is increased. For strong signals, the gains of those stages are reduced. The net result is that the output voltage of V105 is kept fairly constant. The feedback voltage from the first limiter grid to the grid of RF amplifier stage V8 (*b*(2) above) further tends to produce this result particularly for strong signals. The above also explains why the grid circuit of V104 is chosen as the source of control voltages for the squelch oscillator.

## 32. Discriminator

(fig. 23)

*a. Discriminating Function.* The discriminator circuit shown in figure 23 is a Foster-Seely discriminator in which the dc path is slightly modified. The discriminator circuit functions to convert the frequency variations of the incoming signal into audio frequencies for application to the AF amplifier stages. Frequency variations of the signal from the 1.4-mc center frequency at the input to the discriminator are translated into amplitude variations of the signal at the output of the discriminator. The rate with which the frequency varies from the

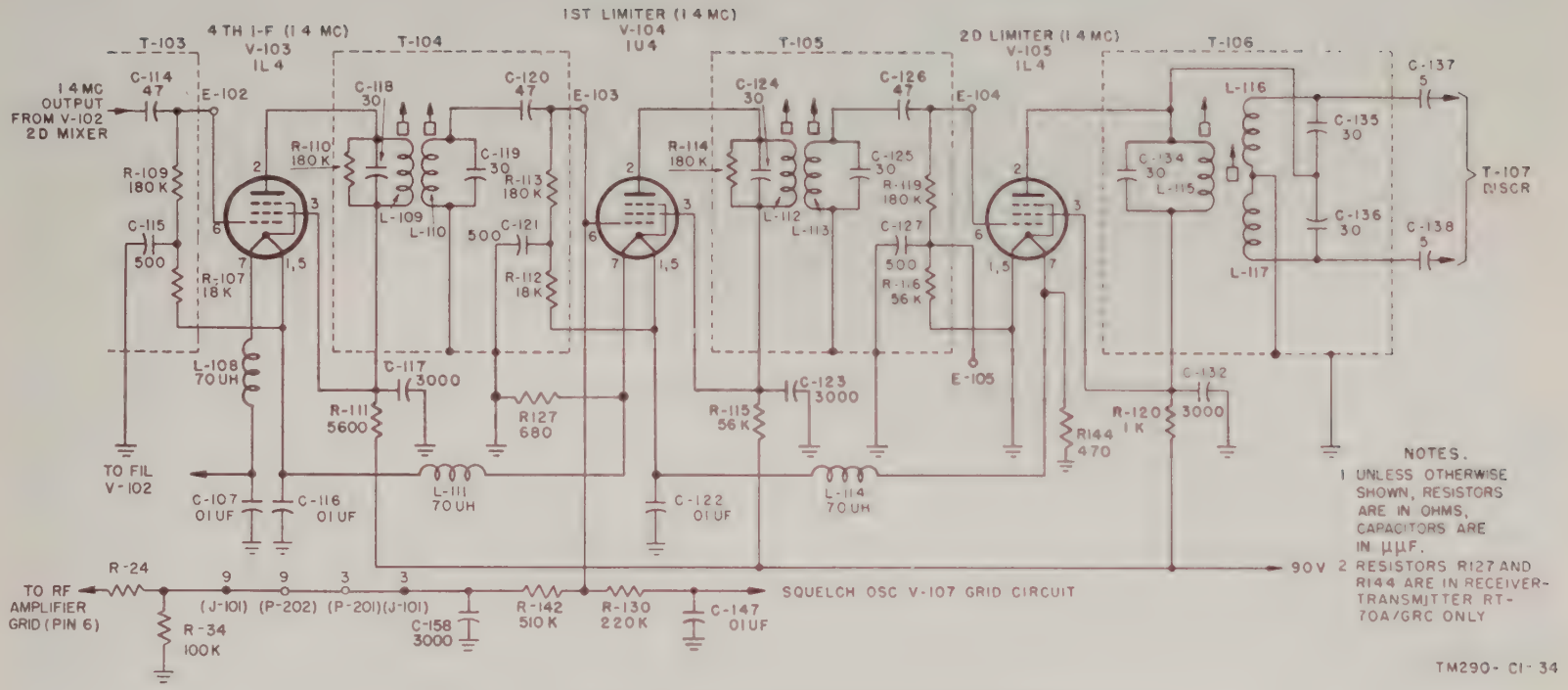


*Figure 22. Receiver 1.4-mc IF amplifier and limiter circuits, functional diagram.*

1.4-mc center frequency is translated into the rate at which the amplitude of the voltage at the output of the discriminator changes. Since the rate with which the signal frequency changes from 1.4 mc is the AF rate, the rate of changes in the amplitude of the discriminator output voltage determines the frequency of the audio output signal.

*b. Circuit Arrangement.* The discriminator circuit includes the secondary tuned circuit in tuning unit T106, capacitors C137 and C138, and the discriminator rectifier circuit. The tuned portion of the discriminator circuit in T106 consists of two balanced coils L116 and L117 shunted by two balanced capacitors C135 and C136. The inductance of each of the coils is equal to the inductance of primary coil L115. Each of the two capacitors, C135 and C136, is equal in capacitance to the capacity of C134 in the primary circuit. The combined values of C135 and C136 tune the total inductance provided by L116 and L117 to resonance at 1.4 mc. Capacitors C135 and C136 have the additional functions of blocking dc current from flowing through the discriminator coils and of maintaining the discriminator balance for signal frequencies. In a Foster-Seely discriminator circuit conventionally drawn, the plate is shown connected to the center tap of the discriminator coil. Here, however, the connection is made to the center tap of the capacitors, which electrically constitutes the same point as the center tap of the coil. The rectifier circuit consists of rectifiers CR101 and CR102, each a type 1N34 (or 1N34A) germanium crystal diode, rectifier load resistors R122 and R123, and discriminator load impedances C143 and L119. Coil L119 is a dc return path for the rectifier circuit. Its high impedance at intermediate frequencies prevents HF current from flowing through it. It represents an effective short circuit for dc and AF. This is a departure from the conventional method of showing the Foster-Seely circuit. Capacitors C137 and C138 block dc from the tuned circuit.

*c. Discriminator Operation.* The output of second limiter stage V105 is connected to the discriminator circuit over two paths. One path is by direct connection from the plate (pin 2) of V105 to the electrical center of the discriminator at the junction of capacitors C135 and C136. The other path is established by inductive coupling from the primary tuned circuit (coil L115) to the secondary tuned circuit (L116 and L117).

(1) The voltage applied to the two rectifiers by direct connection through C135 and C136 from the plate of V105 are equal to each other and are at all times in phase with each other and with the plate voltage of V105. At resonance, that is, when a 1.4-mc signal enters, the primary and secondary circuits are essentially resistive impedances and no reactive component is imparted to the signal voltage by the coils and capacitors. Since L116 and L117 are arranged in a series-aiding connection, the voltage induced in them from L115 is positive at one end and negative at the other. The total voltage across L116 and L117 is equal to twice that across L115. The voltages applied by induction to the rectifiers are 180° out of phase with each other, and each is 90° out of phase with the voltage at the plate of V105 and with the voltage component applied by direct connection to the rectifiers. At resonance, the resultant voltages appearing across rectifier load resistors R122 and R123 are equal in magnitude and opposite in polarity. The net voltage across C143 at the output of the discriminator is zero as measured between test point E106 and chassis.

(2) When the signal frequency deviates from the resonant frequency, the tuned circuits are no longer resistive and impart a reactive component to the voltages applied to the rectifiers by induction. The voltage component applied to the rectifiers by direct connection remains unchanged with respect to the voltage appearing at the plate of V105. The 90° phase relationship between the two voltage components no longer holds. The amount of change in phase at the two rectifiers is the same but opposite in sense. The resultant voltages applied across the rectifiers are no longer equal and opposite in polarity. A net voltage (other than zero) is, therefore, developed across load capacitor C143. For frequencies below resonance, the tuned circuits show an inductive reactance, and the inductively coupled voltage component is shifted in phase in the leading direction. The larger resultant voltage is then applied to CR101, the output voltage across R122 is larger than that across R123, and the net output voltage of the discriminator is positive at the junction of R122 and C143.

For frequencies above resonance, the tuned circuits show a capacitive reactance, the inductively coupled voltage is shifted in phase in the lagging direction, and the larger resultant voltage is applied across CR102. The rectified voltage across R123 is larger than that across R122 and the net voltage at the output of the discriminator is positive at the junction of R123 and C143.

(3) Since, for a modulated signal, the frequency shift above and below the resonant frequency occurs at the AF rate, the changes in voltage across rectifier load resistors R122 and R123 occur at the AF rate. The resulting alternating voltage developed across load capacitor C143 and delivered to the following stage through isolating resistor R124 and coupling capacitor C141 represents the audio frequencies originally transmitted from the distant transmitter.

*d. Discriminator Characteristics.* For proper operation of the discriminator, the circuit *must* be balanced for both signal voltages and for dc currents. Signal balance is maintained by adjusting the coils in the tuned circuits to be exactly equal to each other. Similarly, the tuning capacitors are equal to each other. Dc balance is obtained by keeping load resistors R122 and R123 equal in value and, in addition, by making sure that the forward and backward resistances of one rectifier are equal at all times to the corresponding resistances of the other rectifier. For a properly adjusted and operating discriminator circuit, the voltage (or current) measured at test point E106 (or terminal 7 of T107) when a 1.4-mc signal of 2 volts is applied to the input of V105, is zero ±.5 volt. For a signal which is either 30 kc above or 30 kc below the 1.4-mc center frequency, the voltage measured at test point E106 (pin 7 of T107) should be ±.5 volt minimum, depending on whether the higher or lower frequency is involved. The two voltages thus measured should be nearly equal to each other. Failure to obtain the zero ±.5 reading indicates improper tuning of the discriminator. If the two voltages for the two frequencies (30 kc above and below 1.4 mc) are not equal, or nearly equal, then the discriminator is off balance. Normally, when a fixed component of the discriminator, for example, balanced capacitors C135 and C136 or resistors R122 and R123, is defective, balance in the discriminator is lost. Unbalance which is not caused by a defective component may be restored by adjusting the powdered iron cores of L116 and L117. The powdered iron core of L116 and L117 is adjusted first to give a reading of zero ±.5 volt at 1.4 mc. The powdered iron core of L115 then is adjusted to give approximately equal peak voltages (about 11 volts) at the frequencies 70 kc above and 70 kc below the center (1.4-mc) frequency. If the bandwidth is incorrect, that is, the ±15-volt minimum reading is not correct, then adjustment of coil L115 by means of the powdered iron core is necessary. Of course, this assumes that the preceding stages are properly alined and the oscillators are on frequency.

*e. Discriminator Output Circuit.* The output of the discriminator is coupled through isolating resistor R124 and coupling capacitor C141 to the grid (pin 4) of first af amplifier V106. During transmission, signals from the sidetone circuit are also applied through C141 to the grid of V106. The sidetone circuit is described in paragraph 37.

*f. Beat Oscillator Input.* When the beat oscillator (part of V106) is turned on by means of test switch S202, its output is applied through coupling capacitor C140 to the input of the discriminator rectifier circuit at the junction of C137 and CR101. This 1.4-mc signal is then rectified in the discriminator rectifier circuits. The resultant voltage appearing at the output of the discriminator is then used as a comparison voltage to aid in the alinement of the receiver-tuned circuits. For a detailed description of the beat oscillator and its use in receiver alinement and testing, see paragraphs 39 and 40.

*g. Discriminator Measuring Circuit.* Test point E106 is a terminal in the discriminator output circuit at the junction of R124 and C142. Measurement of discriminator output is made between test point E106 and chassis. Capacitor C142, in conjunction with coupling capacitor C141 and grid leak resistor R121, serves as an HF deemphasis network for the purpose of reducing the noise voltages at the input of the audio amplifier and shaping the AF response characteristic at its high end.

## 33. First Audio Amplifier V106
(figs. 24 and 25)

*a.* The signal output of the discriminator is routed through the deemphasis network consisting of grid leak resistor R121, capacitor C142, coupling capacitor C141, and resistor R124, to the grid (pin 4) of first audio amplifier stage V106. The deemphasis network is in effect a low-pass filter functioning to

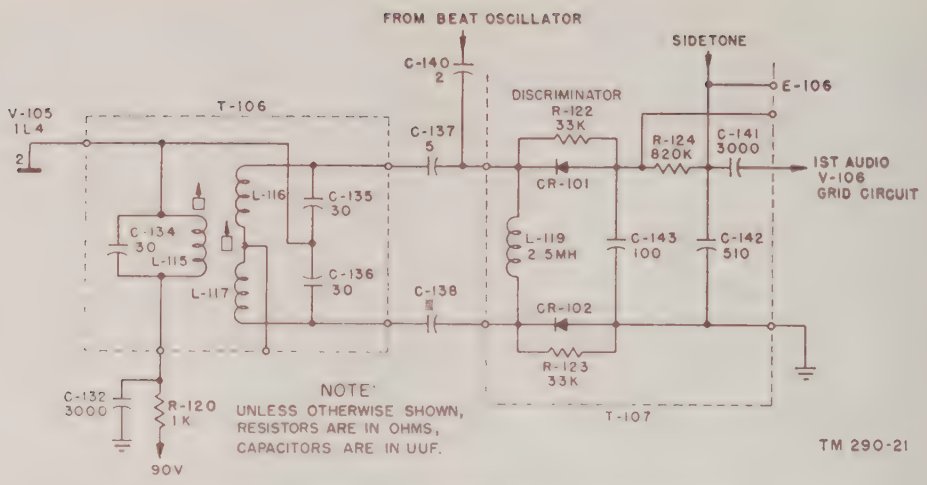


*Figure 23. Receiver discriminator circuit, functional diagram.*

counteract the preemphasis imparted to the higher audio frequencies by the transmitter. The network limits the band of audio frequencies applied to the first audio amplifier thereby removing the noise voltages that appear at the high end of the AF range.

*b.* In Receiver-Transmitter RT–70/GRC, tube V106, a type 1R5 pentagrid converter, serves the dual functions of first audio amplifier and beat oscillator (fig. 24). The control grid (pin 4) and the screen grid (pin 3) serve as the control grid and plate for the first audio amplifier stage. (The other tube elements, pins 6, 3, and 2, serve as the control grid, screen grid, and plate of the beat oscillator. In Receiver-Transmitter RT–70A/GRC (fig. 25), tube V106 is a 3A4 twin-triode. The beat oscillator is described in paragraph 39.

*c.* The amplified audio output is developed across load resistor R129 and is coupled through capacitor C145 and through pins 2 of chassis connectors J101 and P202 to VOLUME control R204. This control is located on the front panel of the set and serves to adjust the output level of the receiver. The movable arm of the VOLUME control is connected through pins 6 of chassis connector P202 and J101 to the grid circuit of second audio amplifier stage V108.

*d.* In Receiver-Transmitter RT–70/GRC, B+ potential is applied to pin 3 of V106 from the 90-volt supply through resistor R129. In Receiver-Transmitter RT–70A/GRC, B+ is applied to pin 6 of V106 (fig. 25) through R129. The filament circuit of both models includes isolating choke L118 and filter capacitors C144 and C155A.

## 34. Second Audio Amplifier V108
(figs. 24 and 25)

*a.* Tube V108, a type 3Q4 pentode, serves as the receiver second audio or power amplifier stage. The output of first AF amplifier V106 is applied to the grid (pin 3) of V108 through coupling capacitor C145, VOLUME control R204, and the low-pass filter network consisting of shunt capacitor C153 and the series elements of C154 and R141. The network serves to reduce HF noises at the input of the amplifier and to deemphasize the higher audio frequencies as compensation for the preemphasis imparted to them by the distant transmitter. Resistor R141 also reduces the AF voltage appearing at the grid of V108 to prevent overdriving this tube.

*b.* The grid circuit includes the series arrangement of resistors R133, R132, and R131. Ground return for audio signals is established through R133 and bypass capacitor C155B. Resistors R132 and R131 establish the dc grid return to ground. Resistor R131 serves also as the load resistor for the squelch diode in V107, across which squelch bias for both second audio amplifier V108 and for RF amplifier V8 is developed. Two bias voltages are provided to determine the operation of V108. One is the self-bias provided by the voltage drop across filament circuits. This voltage sets the operating point for the amplifier during reception. The other voltage is the bias voltage developed across R131 by the squelch circuit when the receiver is in standby. When the receiver is in standby and the squelch circuit is operative, the sum of the voltages across R131 and the filaments drives V108 to cutoff. The bias voltage provided by the squelch is filtered by

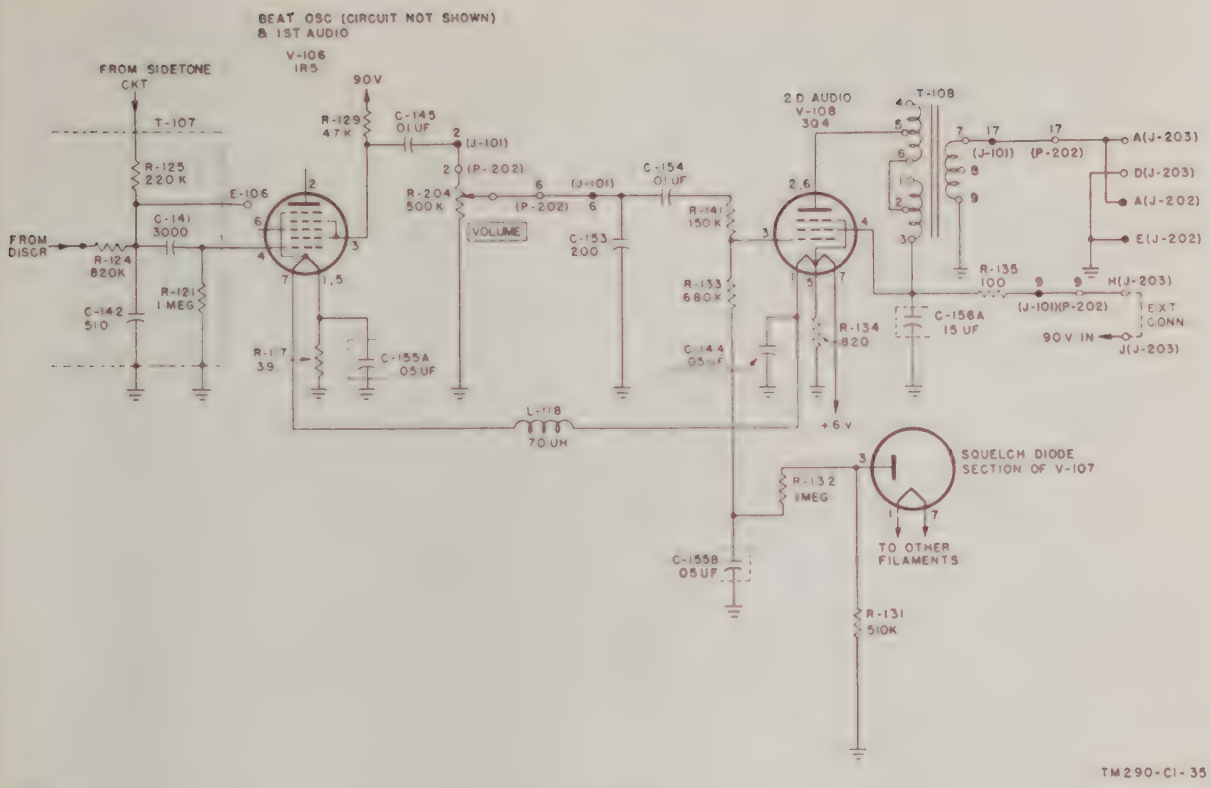


*Figure 24. Receiver-Transmitter RT–70/GRC receiver audio amplifier circuits, functional diagram.*

C155B. When the squelch is turned off, either by means of the squelch switch of by an incoming on-frequency signal, the bias voltage across R131 is removed and the tube is restored to operation as a class A amplifier. For a detailed description of the squelch circuit, refer to paragraph 35.

*c.* The amplified output of V108 is coupled through plate load transformer T108 to the audio output connection, terminal A of POWER connector J203, and to the phone connection, terminal A of AUDIO connector J202. Both connectors are located on the front panel.

*d.* Plate and screen voltages for V108 are supplied as follows: The plate and screen circuits are extended through decoupling resistor R135 and terminals 9 of chassis connectors J101 and P202 to terminal H of J203. Terminal H of J203 is connected to terminal J of J203 and the 90-volt supply by a connection through AF Amplifier AM–65/GRC and the mounting used with the radio set (or Control C–435/GRC when used). The connection may be a jumper strap, the contacts of an external relay, the coil of an external relay, or the contacts of a switch. The exact nature of the connection depends on the arrangement of the particular system in which the receiver-transmitter is used. In connection with troubleshooting and maintenance of Receiver-Transmitter RT–70(*)/GRC, no plate or screen voltages exist at the tube pins unless the connection between H and J of J203 is made. If the coil of a relay is connected between these terminals, the relay will be energized when V108 draws plate current and will be deenergized when V108 plate current is cut off. Thus, when the receiver is in the standby condition, and the squelch circuit cuts off the audio amplifier plate current, the relay connected will be deenergized. When an incoming signal cuts off the squelch circuit and V108 plate current begins to flow, the external relay becomes energized. This arrangement is used when the receiver-transmitter is to be used in a retransmission system in which it is necessary that the incoming audio signal itself takes over the push-to-talk function of turning on the transmitter.

## 35. Squelch Circuit V107

(fig. 26)

*a.* The carrier-operated squelch circuit uses a type 1S5 tube, V107. The tube combines a pentode

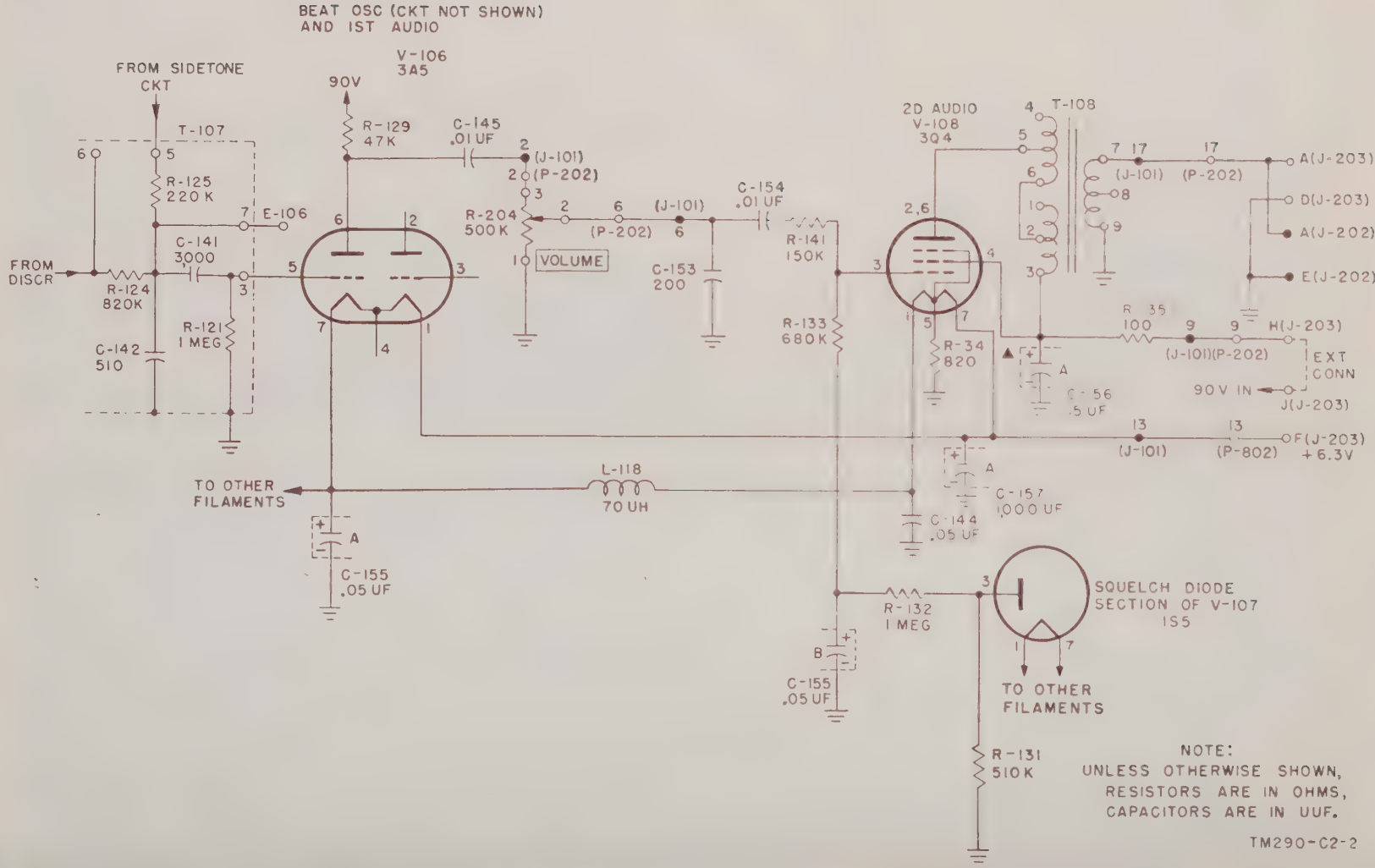


*Figure 25. Receiver-Transmitter RT-70A/GRC receiver audio amplifier circuits, functional diagram.*

and a diode in one envelope. The pentode is arranged to form a tuned-plate, tuned-grid oscillator. The diode rectifies the oscillator output. This circuit keeps the second audio amplifier and the receiver RF amplifier biased to cutoff during no-signal conditions of the receiver, and turns on the audio amplifier and the RF amplifier when a signal enters the receiver. Details of operation of the squelch circuit are described in *b* through *f* below.

*b.* The oscillator circuit includes the grid winding (terminals 3 and 4) and the plate winding (terminals 1 and 2) of transformer T109. No capacitor is shown connected across either of the two windings since the tuning is accomplished by the interelectrode capacitance of the tube and the stray capacity in the wiring. The oscillator generates a frequency in the region of 30 kc. Regenerative feedback to sustain oscillations is established partially through coupling between the plate and grid windings of T109, and partially through capacitor C146. The grid circuit of the oscillator extends through resistor R130, which is bypassed by capacitor C147, to the grid of first limiter tube V104. The grid circuit of V107 is returned to the filament of V107 through resistor R126, to provide correct bias. Resistors R113 and R112 in the grid circuit of V104 are, in effect, also in the grid circuit of V107. Thus, any voltage developed across these resistors is applied not only to V104 but as bias to the grid of V107. The squelch oscillator bias is a combination of self-bias developed by V107 and the first limiter grid voltages. When no signal is present in the receiver, noise voltages developed across R113 and R112 add to the self-bias across R126. The combined bias voltages applied to the grid of V107 are low enough to sustain oscillation. When a signal enters, the voltage across R113 and R112 is increased so that the oscillator is driven to cutoff and oscillations cease. Resistor R143 serves to load the oscillator and to reduce the effects of circuit variations.

*c.* The output of the oscillator is coupled through capacitor C151 to the plate (pin 3) of the diode section of V107. When the oscillator is operative, its output is rectified by the diode circuit. The rectified voltage is developed across diode load resistor R131.

*d.* The rectified output voltage developed across R131 is applied to the grid of second audio amplifier V108 through resistors R132 and R133. Capacitor C155B filters this voltage. The magnitude of the voltage developed across diode load resistor R131 and therefore the magnitude of the squelch bias voltage applied to V108 are proportional to the amplitude of squelch oscillator output. The manner in which the amplitude of the oscillator output is controlled is discussed in *e* below.

*e.* Plate voltage for the oscillator section of V107 is applied from the 90-volt source through voltage-dropping resistor R139 and through the primary winding (terminals 1 and 2) of T109. Capacitor C156B and C156C acts as an RF bypass and plate supply filter capacitor. Screen voltage is obtained from the 90-volt source through SQUELCH potentiometer R202 and switch S201. The screen supply circuit is bypassed by capacitator C150. This potentiometer and S201 are mechanically assembled so that when the SQUELCH potentiometer is in the extreme counterclockwise (OFF) position, the switch is open and disconnects screen voltage from V107, thereby disabling the squelch circuit. Resistor R201, in shunt with the used portion of potentiometer R202, serves to give more gradual control of the screen voltage and to improve voltage regulation. The level of the signal generated by V107 is determined by two factors. One is the setting of R202. When this potentiometer is in its maximum clockwise position the full 90 volts is applied to the screen. The output level of the oscillator is then high and the squelch bias voltage developed across R131 is relatively large. As R202 is rotated in the counterclockwise direction, the applied screen voltage, the level of the generated oscillator output, and the diode output voltage across R131 are reduced accordingly. The other factor affecting the output level of the oscillator is the bias voltage applied to its grid circuit. The greater the bias (in the negative direction) the lower the amplitude of the oscillator output and vice versa. The magnitude of the bias voltage is a function of the gain layout of the receiver under the particular condition of operation. When RF amplifier V8 is biased by the grid-bias voltages developed by first limiter V104 and squelch oscillator V107 circuits, the gain imparted to noise voltages is reduced. Therefore, the setting of the SQUELCH potentiometer, the input sensitivity of the receiver, the gain layout of the receiver, and the oscillator output level are interrelated.

*f.* Under no-signal conditions when the oscillator is operative, the squelch bias voltage applied to V108 in the manner described in the preceding paragraphs is sufficient to drive V108 to cutoff. When an on-signal frequency enters the receiver, it

reaches the grid of first limiter V104 and biases the squelch oscillator to cutoff, thereby stopping the oscillation. The rectified voltage disappears from across R131 and bias is removed from V108. This tube is restored to normal operation as a class A amplifier. For any setting of the SQUELCH potentiometer, a certain minimum level of the signal is required to produce a bias voltage at the input of the first limiter large enough to cut off the squelch oscillator. When the SQUELCH switch is in the OFF position, the oscillator is automatically disabled and audio amplifier V108 is operated at full gain.

associates the grounded contacts of the microphone push-to-talk switch, of a control relay, or of a control switch, with one of these terminals. Normally, these ground return connections are opened and the relays are not energized, maintaining the receiver-transmitter in receiving condition. When the microphone push-to-talk switch, the control relay, or the control switch is operated, ground return is applied, current flows through the relay coil, and the relay becomes energized. The resultant transfer of the relay contacts performs the functions outlined in *c* below.

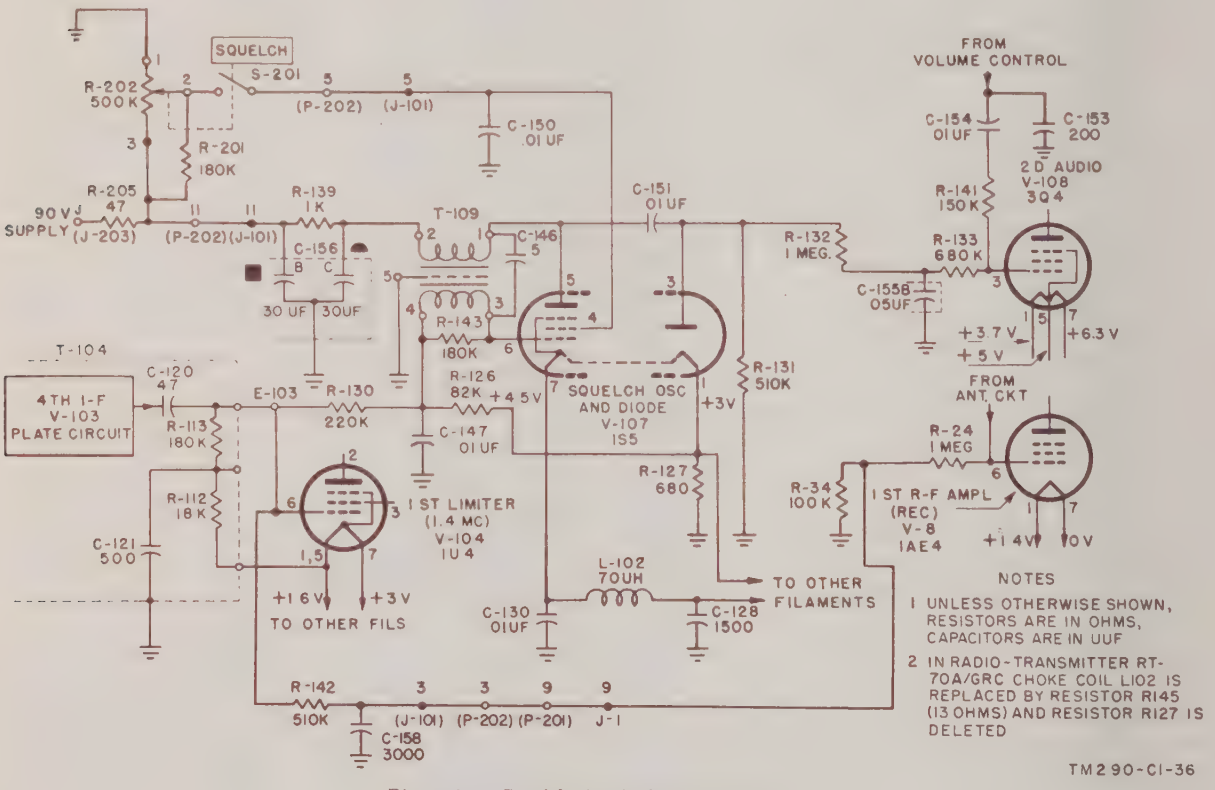


*Figure 26. Squelch circuit, functional diagram.*

## 36. Control Circuits
(figs. 27 and 28)

*a. General.* The push-to-talk function of Receiver-Transmitter RT–70(*)/GRC is performed by relay O 101, mounted on the RF chassis. One side of the coil extends to terminal B of J203, which is the 6.3-volt relay supply connected to the power supply. The other side connects to terminal F of J202 and to terminal K of J203. These are the ground return connections for the relay circuits. System wiring in external components (AF Amplifier AM–65/GRC, mounting, control boxes, etc.)

*b. Relay O 101 Unenergized.* When relay O 101 is unenergized, its contacts establish the following circuit conditions:

(1) Contacts 1 and 2 are closed to connect the 6-volt supply (terminal F of J203) to the filaments of receiver tubes V8 through V11, V101 through V105, and V107 and calibrate oscillator tube V7.

(2) Contacts 2 and 3 are open, with the result that energizing voltage for the filaments of

transmitter tubes V1, V3, V5, and V6, and for the microphone, is disconnected.

(3) Contacts 4 and 5 are closed and load resistor R136 is placed across the 90-volt supply when switch S101 is in the TANK or VEH position. The switch is placed in these positions when the vibrator power supply unit (Power Supply PP-281/GRC and a 12-volt storage battery, PP-282/GRC and a 24-volt storage battery, or PP-448/GR and a 6-volt storage battery) is used to supply power through AF Amplifier AM-65/GRC. Under these conditions, the load circuit is placed across the 90-volt supply to equalize the drain on the supply during the receiving and transmitting conditions. When switch S101 is in the FIELD position (when the receiver-transmitter is operated from dry batteries), the equalizing load is not necessary and is therefore disconnected.

(4) Contacts 6 and 7 open to break the sidetone circuit.

(5) Contacts 8 and 9 open to break the 90-volt supply to the screens of transmitter tubes V1 and V6.

*c. Relay O 101 Energized.* When relay O 101 is energized (*a* above) its contacts rearrange the circuit as follows:

(1) Contacts 1 and 2 open to break the filament supply to receiver tubes V8 through V11 and V101 through V105, to calibrate oscillator tube V7, and squelch oscillator V107.

(2) Contacts 2 and 3 close to complete the filament supply circuits to transmitter tubes V1, V3, V5, and V6, and the microphone supply circuit to the primary winding of microphone transformer T1.

(3) Contacts 4 and 5 open to disconnect compensating load resistor R136 from across the 90-volt supply.

(4) Contacts 6 and 7 close to complete the sidetone circuit. The sidetone circuit extends from terminal 2 (tap on secondary winding) of T1, through pins 10 of chassis connectors J1 and P201, pins 8 of chassis connectors P202 and J101, resistor R140, over contacts 6 and 7 of the relay, through R125 and coupling capacitor C141 to the grid (pin 4) of first AF amplifier V106. When switch S101 is in the VEH or FIELD position, the level of sidetone routed from the microphone circuit to the receiver audio amplifier is reduced by voltage division through R138.

(5) Contacts 8 and 9 of the relay close and connect the 90-volt supply source to the screens of transmitter tubes V1 and V6.

*d. Summary.* A review of the detailed analysis of *b* and *c* above shows—

(1) When the relay is unenergized, the receiver is fully operative. The transmitter and sidetone are not operative as some of the filament and screen voltages on the transmitting tubes are removed.

(2) When the relay is energized, the transmitter is fully energized, the sidetone circuit is completed, and microphone energizing potential is made available. The receiver, however, is not energized, since the filaments of the HF circuits (RF and IF) are disconnected from the supply circuits.

(3) The squelch oscillator is disabled since the filament supply circuit for V107 is open in the energized position of the relay. The 32- to 43.4-mc variable oscillator is fully energized at all times, since it serves both the receiver and the transmitter.

(4) Special purpose circuits, such as the calibrate, beat, and squelch oscillators, have their own power supply arrangements. For detailed description, see paragraphs 35, 38, 39, and 40.

(5) The second audio amplifier plate supply circuit is completed externally (par. 41).

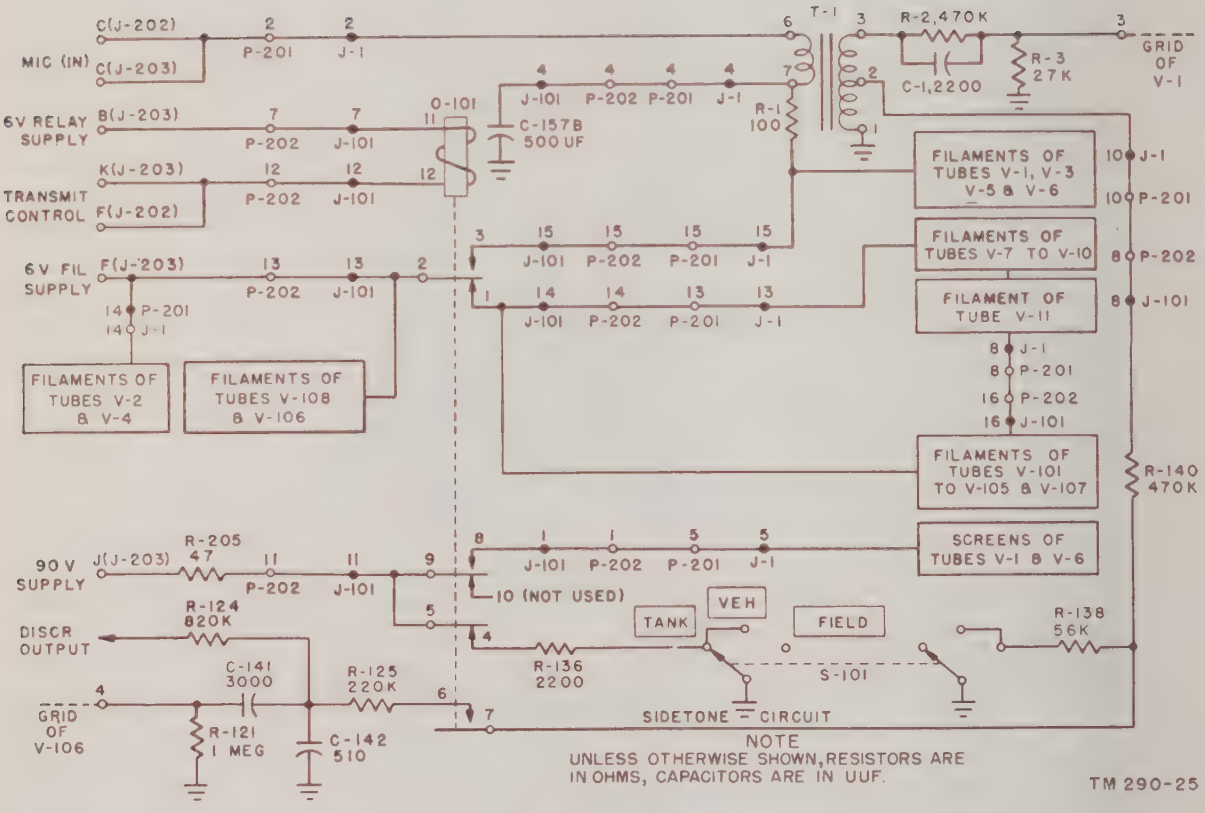


*Figure 27. Receiver-Transmitter RT-70/GRC control circuits, functional diagram.*

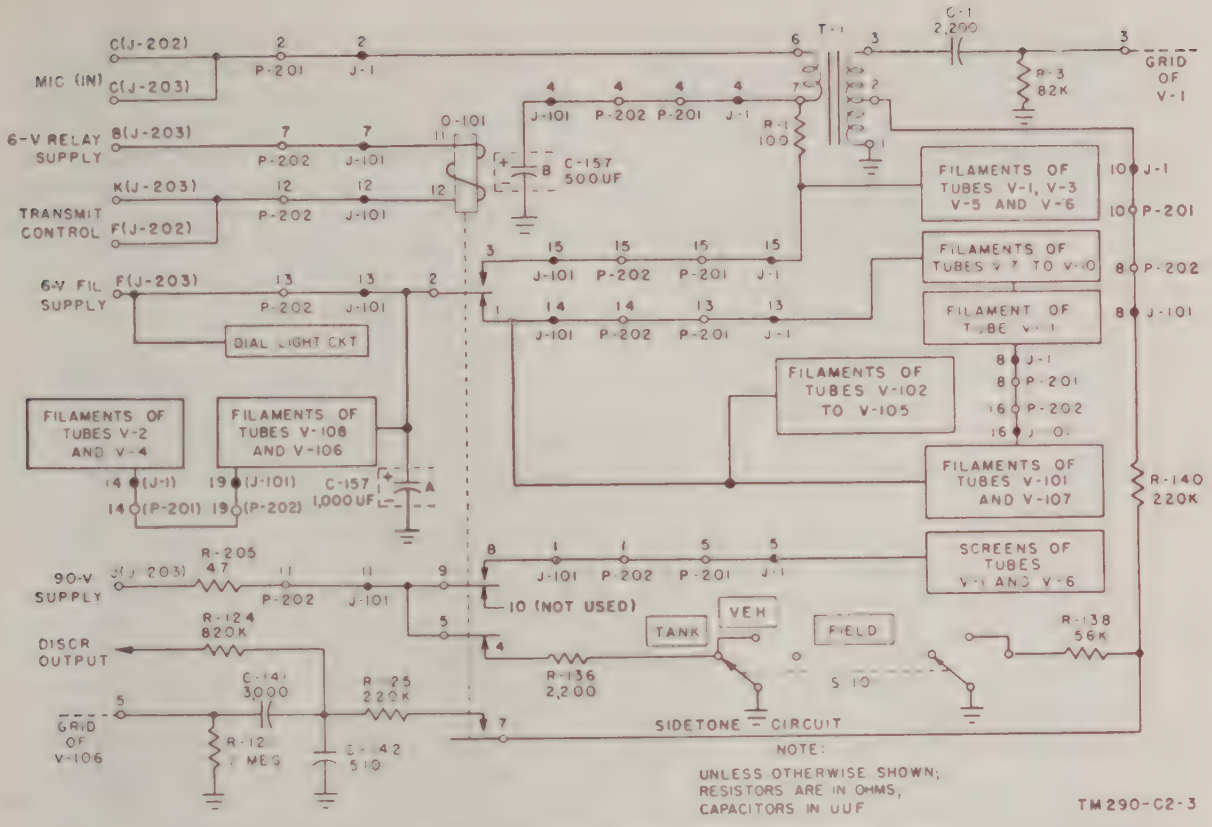


*Figure 28. Receiver-Transmitter RT–70A/GRC control circuits, functional diagram.*

## 37. Sidetone Circuit

*a.* A portion of the speech signals applied to the microphone circuit for transmission through the transmitter is diverted over a separate path to the input of the receiver first audio amplifier, is amplified there and in the receiver second audio amplifier, and appears at the receiver output terminals. The path over which these signals are routed is called the sidetone circuit, and the audio signals are called sidetone signals, or sidetone. In ordinary commercial telephony, sidetone is returned to the earpieces of a handset to insure a natural effect to the user, since without sidetone a hollow, resounding effect would be evident in the earpiece. In a typical system installation in which Reciver-Transmitter RT–70(*)/GRC is used, this purpose is accomplished. In addition, the sidetone signals appearing at the receiver output terminals are routed by system wiring to control positions for monitoring by other personnel.

*b.* The sidetone voltage developed across a portion of secondary winding 1–2 of microphone input transformer T1 (figs. 11 and 12) is routed over terminals 10 of chassis connectors J1 and P201, over terminals 8 of chassis connectors P202 and J101, through voltage-dropping resistor R140, over contacts 7 and 6 (when closed) of relay O 101, through voltage-dropping resistor R125 (figs. 24 and 25), and coupling capacitor C141, to the grid (pin 4) of V106, the receiver first audio amplifier stage. The signal is amplified in this stage and in the second audio amplifier stage and is applied to the receiver audio output terminals. The audio circuits are fully operative during transmit periods, since operation of relay O 101 opens the filament supply circuit for V107, the squelch oscillator tube. With this tube nonconducting, the squelch circuit is disabled and squelch bias is removed from the grid of V108 (par. 35).

*c.* When the receiver-transmitter is used in a vehicular or field installation, and switch S101 (figs. 11 and 12) is set in either the VEH or FIELD position, the level of the sidetone is reduced by shunting resistor R138 across the sidetone circuit. This shunt extends from the junction of R140 and contact 7 of relay O 101, through R138 and the contacts of S101 to ground. Resistors R138 and R140 form a voltage divider, which reduces the

level of the sidetone signal applied to the grid of V106 by about 70 percent. This arrangement is necessary to prevent acoustic feedback when a handset or loudspeaker is used. Full sidetone is provided when headphones are used.

*d.* The level of sidetone appearing at the grid of V106 may be measured at test point E106 (figs. 24 and 25). The sidetone circuit provides means for checking the operation of the microphone circuit and of the audio amplifier circuits since the absence of sidetone during transmission is an indication of a fault, while presence of sidetone is a positive indication of signal continuity in those circuits.

## 38. Calibrate Oscillator V7
(figs. 29 and 30)

*a.* A tube type 1U4 pentode, V7, is used as a triode connected crystal oscillator. The grid (pin 6) circuit of the oscillator includes the parallel arrangement of 1-mc crystal Y2, fixed trimmer capacitor C45, and grid leak resistor R22. The plate (pin 2) and screen (pin 3) are tied together to provide triode operation of the tube. The plate circuit includes tuned circuit L21 and trimmer capacitor C48. The plate circuit extends through the tuned circuit mentioned above, and through voltage-dropping resistor R23, which is bypassed by capacitor C49 to positions 1 and 4 of ANT ADJ-DIAL LIGHT (ON-OFF)-CAL switch S202 on the front panel. When the switch is in either one of these two positions, the 90-volt supply is connected to the plate circuit of calibrate oscillator V7 and this circuit becomes operative. The oscillator generates a fundamental frequency of 1 mc and many harmonics. In the other two positions (DIAL LIGHTS ON-OFF) of the switch, the plate voltage is disconnected from the tube and the oscillator is inoperative.

*b.* The output of the oscillator is connected on a permanent basis to the input of receiver first RF amplifier V8 through coupling capacitor C47. The harmonic of the oscillator selected by the tuned circuits of the receiver depends on the frequency to which the receiver-transmitter is tuned by means of the dial on the front panel. For example, if the receiver-transmitter is tuned to 47 mc, the 47th harmonic of the output of V7 is selected by the receiver and is routed through the receiver circuits.

*c.* The oscillator output is used in conjunction with the beat oscillator, part of V106 (par. 40), to calibrate 32- to 43.4-mc oscillator V2 when the test switch is in the CAL position, or without the beat oscillator for adjustment of antenna trimmer capacitor C41 when the switch is in the ANT ADJ position. Filament voltage is applied through isolating choke coils L20 and L22. Capacitors C68 and C50 are filament supply bypass capacitors. In Receiver-Transmitter RT–70A/GRC, current limiting resistor R39 is connected from pin 7 of V7 to ground.

## 39. Beat Oscillator V106
(figs. 29 and 30)

*a.* In Receiver-Transmitter RT–70/GRC, a portion of tube V106, a type 1R5 pentagrid converter, is used as a crystal-controlled oscillator generating a frequency of 1.4 mc. The signal grid (pin 6) of the tube is used as the oscillator control grid, and the plate (pin 2) is used as the oscillator plate. Grid 1 (pin 4) is used as the first audio amplifier control grid, and the screen grid (pin 3) is used as the audio amplifier plate (par. 33). While there is some electrical interaction between the output of the amplifier and that of the beat oscillator, this interaction is negligible from the point of view of the operation of the circuits. The output of the oscillator is used in conjunction with the output of the calibrate oscillator (pars. 38 and 40) to produce a beat note, as an indication of the proper tuning of 32- to 43.4-mc oscillator V2.

*b.* In Receiver-Transmitter RT–70A/GRC, the beat oscillator uses a triode section of V106 (twin-triode 3A5). The other triode section of this tube is used as the first audio amplifier (par. 33*b*). The oscillator is crystal-controlled and generates a frequency of 1.4 mc. Pins 3 and 2 are used as the control grid and plate of the oscillator. As in Receiver-Transmitter RT-70/GRC, the beat oscillator is used in conjunction with the output of the calibrate oscillator (pars. 38 and 40) to produce a beat note as an indication of the proper tuning of 32- to 43.4-mc oscillator V2.

*c.* The oscillator *grid* circuit includes grid resistor R118 and capacitor C131. In Receiver-Transmitter RT–70/GRC, the grid circuit is returned for dc to the filament (pin 1) of V106. This point is placed at RF ground potential by bypass capacitor C155A. In Receiver-Transmitter RT–70A/GRC, grid leak resistor R118 and its bypass capacitor, C131, are returned to the filament at pin 4 (fig. 30). The pin 7 end of the filament is returned to ground for RF by capacitor C115A; the pin 1 end is returned to ground by capacitor C157A.

These two capacitors keep the filament at RF ground potential. The 1.4-mc crystal is connected between the plate and the grid. The plate circuit extends through load resistor R128 and through the CAL contacts (position B4) of switch S202 to the 90-volt plate supply. Thus, the beat oscillator has plate voltage applied to it only when S202 is in the CAL position. Otherwise, the oscillator is not operative. The oscillator circuit is effectively that of a Pierce oscillator, with the feedback (from plate to grid) being set at a fixed frequency of 1.4 mc by quartz crystal Y102. The amount of feedback is determined by the ratio of C133 and C131. The output of the oscillator is applied through coupling capacitor C140 to the input of the discriminator rectifier circuit at terminal 4 of T107 (at the junction of capacitor C137 and discriminator rectifier CR101).

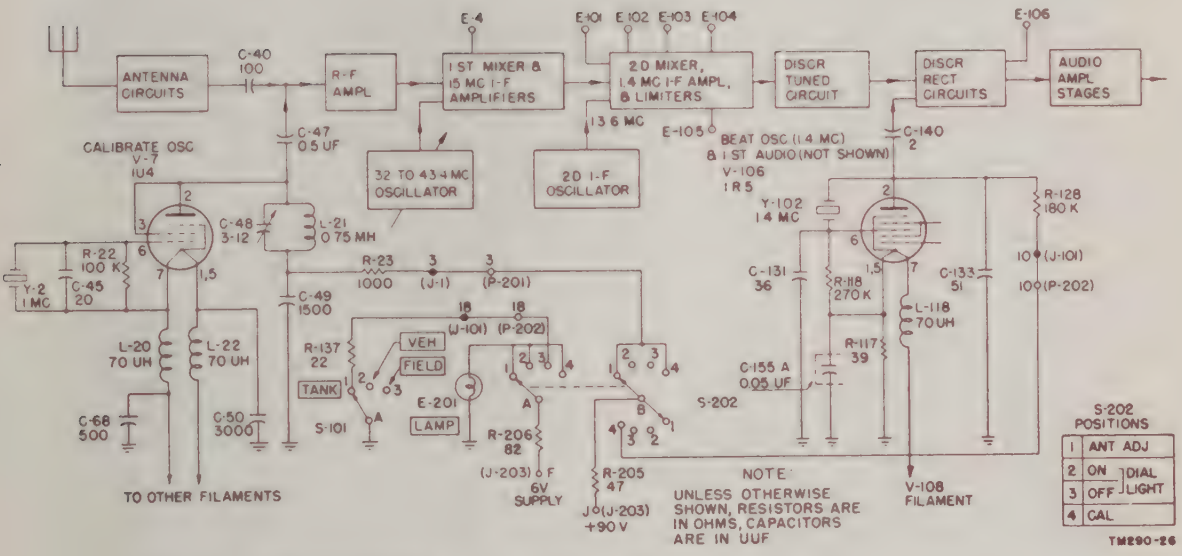


*Figure 29. Receiver-Transmitter RT-70/GRC calibrate and beat oscillator circuits, functional diagram.*

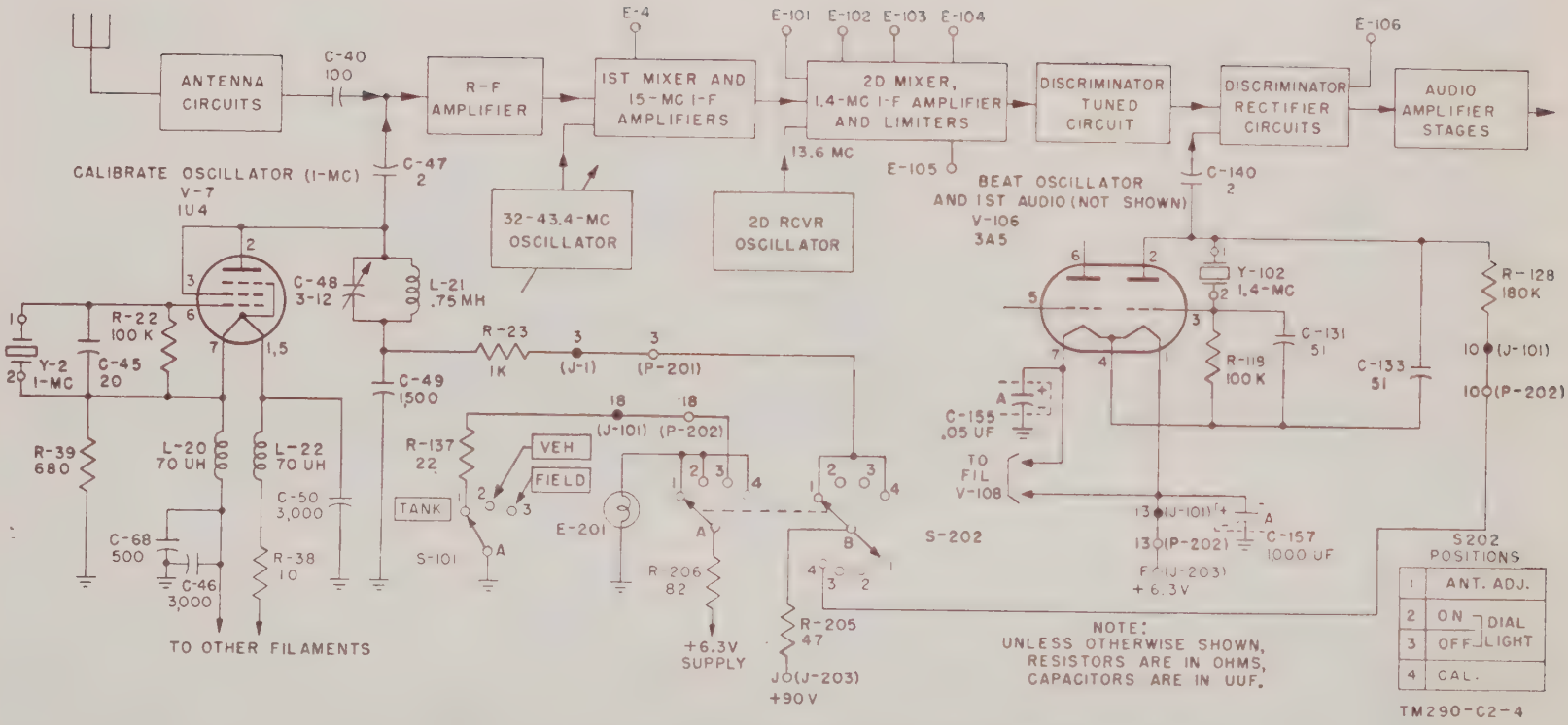


*Figure 30. Receiver-Transmitter RT-70A/GRC calibrate and beat oscillator circuits, functional diagram.*

## 40. Tests and Adjustments with Calibrate and Beat Oscillators

*a.* When switch S202 is in the CAL position and control relay O 101 is not energized, the beat and calibrate oscillators are both energized since plate voltages are applied to them. When the receiver-transmitter circuits are tuned by means of the TENTH-MCS control on the front panel to a frequency which is a multiple of 1 mc, and if the calibration of the tuning dial is correct, the RF circuits of the receiver pick out the proper harmonic of 1 mc generated by the calibrate oscillator. For example, if the receiver is tuned to 47 mc, the 47th harmonic of the output of calibrate oscillator V7 is selected.

(1) This signal is amplified in the first RF amplifier stage, and is applied, together with the output of variable 32- to 43.4-mc oscillator V2, to the input of the first mixer stage.

(2) If, as required, the frequency generated by V2 is 15 mc below the frequency setting of the dial, the frequency at the output of the first mixer stage is 15 mc. If oscillator V2 is not 15 mc below the dial reading, the output of the first mixer stage is not 15 mc but some other frequency, depending on the amount by which the variable oscillator is off frequency. In the case exemplified here, the frequency generated by V2 should be 32 mc. Assuming this to be the case, the 32-mc signal from V2 and the 47-mc signal from calibrate oscillator V7 beat in the first mixer stage to produce the first intermediate frequency of 15 mc.

(3) The 15-mc signal is then amplified and is, in turn, applied together with the 13.6 mc output of second mixer oscillator V102 to the input of the second mixer stage. The resultant beat frequency is amplified in the 1.4-mc IF amplifier limiter circuit and appears as a voltage across the input to the discriminator rectifier circuits. When the above beat frequency is 1.4 mc, the resultant voltages across the discriminator output is close to zero volts.

(4) The 1.4-mc signal voltage and the 1.4-mc output of beat oscillator V106 are applied together to the discriminator rectifier circuit (fig. 23). The signal voltage is applied in normal manner through capacitors C137 and C138. The beat oscillator is, in effect, connected between the junction of CR101 and L119 on one side and ground (junction of CR102 and C143) on the other side. For the purpose under consideration, the rectifier circuit serves as a nonlinear mixing device causing sum and difference frequencies to be produced.

(5) By mixing the incoming IF signal frequency and the frequency generated by the beat oscillator, the sum frequency is rejected by the receiver audio circuits. The difference frequency is in the AF range and is consequently picked up by the receiver audio amplifier circuits for application to the headset or test meter. If the incoming signal is 15 mc above that of V2, and if the frequency generated by V102 is correct, the resultant dc voltage due to the difference frequency measured at E106 is close to zero. If any of these circuit adjustments are not correct and consequently the test signal voltage at the discriminator input is not 1.4 mc, a voltage other than zero is measured at E106. The deviation from zero volts is the measure of the deviation of the test signal frequency from 1.4 mc at the input of the discriminator.

(6) The signal from the calibrate oscillator opens the squelch and turns on the audio circuits just like any other received signal.

*b.* The above discussion is explained by a numerical analysis as follows: Assume that the zero setting of the tuning dial is off; then for a setting of the tuning dial at a marking which is a multiple of 1 mc; for example 47 mc, the actual frequency to which the receiver is tuned is off by the amount of the dial calibration inaccuracy, or 5,000 cycles. The Q of the RF and IF circuits is not sufficiently sharp to discriminate between signals 5,000 cycles away from the nominal frequency. Therefore, even though the tuning is off by 5,000 cycles, the 47-mc test signal from the calibrate oscillator is still being picked up and routed through the receiver, although possibly with some attenuation. The 47th harmonic picked up by the tuned circuits of the first RF amplifier now beats with the frequency generated by V2, which is not 32 mc, but 32 $\pm$ .005 mc. The resultant difference frequency is not 15 mc but 15 mc $\pm$.005 mc. This frequency in beating with the second intermediate oscillator frequency

of 13.6 mc produces a second IF of 1.4 ± .005 mc and 1.4 mc, as required. Similarly, at the output of the tuned circuit of the discriminator, the 1.4 ± .005-mc signal frequency beats with the 1.4-mc output of the beat oscillator to produce a sum frequency of 2.8 ± .005 mc which is rejected by the audio amplifier circuits. The difference frequency, 1.4 ± .005 mc minus 1.4 mc, is 5,000 cycles. This AF is amplified in the audio amplifier circuits and appears as a beat note in the headphones connected to the audio connector pins. If measurement is made at discriminator test point E106 (terminal 7 of T107), the excursion of the meter pointer will be due practically entirely to this difference frequency or beat note. Furthermore, since the discriminator translates a change from 1.4 mc into AF amplitude, the magnitude of the voltage at E106 above or below 0 ± .5 volt is a measure of the amount by which V2 is detuned.

*c.* In some tests, it is desirable to set the tuning dial to the desired frequency and to adjust the tuned circuits to produce a zero beat note at the audio amplifier output. An incoming *on-frequency* signal will produce noise quieting in the receiver output at frequencies near the exact frequency required to produce a zero beat note. Since a harmonic of 1 mc is available from the calibrate oscillator over the entire tuning range of the receiver, a zero beat note is obtainable for any setting of the tuning dial which is a multiple of 1 mc.

*d.* With switch S202 in the ANT ADJ position, beat oscillator V106 is disabled, since plate voltage is disconnected from it. However, calibrate oscillator V7 is on and may be used to make adjustments of the antenna trimmer capacitor. The theory of this adjustment is described briefly below. Antenna circuit adjustment is necessary to match the circuit in the receiver-transmitter to the actual antenna with which the set is to be used. The output of the calibrate oscillator and the RF noise appearing at the antenna of the set (or an external test signal) may be used for making the adjustment. When the adjustment has been made for the receiver, the adjustment will automatically hold for the transmitter, because both the receiver and transmitter are tuned to the same frequency. Noise at the antenna is usually of a random nature as far as frequency is concerned. Therefore, it may be assumed that HF noise signals within the tuning range of the receiver-transmitter are present at the antenna input. When the tuning dial is turned to an mc setting, the antenna tuning circuit picks out these noise signals at the antenna which are in this region and routes them to the receiver. Simultaneously, the tuned RF circuit of the receiver, which may be assumed to be properly calibrated, selects the proper harmonic of the 1-mc output of the calibrate oscillator. The noise signal and the signal from the calibrate oscillator are amplified in the RF amplifier and are applied to the input of the first mixer stage. The signals are amplified at 15 and 1.4 mc and applied to the discriminator which converts the random variations of the noise into an audio signal. When antenna adjusting trimmer C41 is correctly tuned, the increased strength of the signal from the 1-mc oscillator reaching the limiter tubes will cause the limiters to saturate a little more and the noise output of the set will be reduced.

*e.* In a manner similar to that described in *b* above, the calibrate and beat oscillators may be used to check the calibration of variable receiver-transmitter oscillator V2. Adjustment of that oscillator may be made by means of trimmer capacitor C4.

*f.* The output of the calibrate oscillator may also be used for checking the tuning adjustments of the individual stages of the receiver. This procedure involves measuring the output voltages of the individual stages at the *E* test points. For determining whether or not the proper level appears at the several test points, misalinement of an individual stage will show up as a reduction in the output voltage of that stage and of all the succeeding stages. In a similar manner, the center tuning and balance adjustment of the discriminator circuit may be checked by means of the calibrate oscillator.

## 41. Plate and Screen Supply Circuits
(fig. 31)

*a.* The 90-volt supply circuit extends from terminal J of panel connector J203, and is routed over several paths to the plates and screens of the tubes in the receiver-transmitter. One path extends through terminals 11 of P201 and J1 to the plate of power amplifier tube V6. Another path extends through voltage-dropping resistor R205, and branches out through terminals 7 of P201 and J1 to the RF chassis circuits, and through terminals 11 of P202 and J101 to the IF chassis circuits. Auxiliary paths extend to the screen of squelch oscillator tube V107, the plate circuit of the beat oscillator portion of V106, and the plate and screen circuits of calibrate oscillator V7.

*b.* Except for the items listed in (1) through (5) below, all plates and screens are energized directly from the 90-volt source, and are not under control of relay O 101 or of the panel-mounted switches. The exceptions are as follows:

(1) The screen voltages for transmitter tubes V6 and V1 are applied only when relay O 101 is energized and closes contacts 8 and 9.

(2) The plate and screen voltages of V7 are applied only when switch S202 is in either the ANT ADJ or the CAL position.

(3) The plate voltage of the beat oscillator portion of V106 is applied only when switch S202 is in the CAL position. The screen voltage for that tube is applied directly from the 90-volt source, since the screen serves as the plate of the first audio amplifier.

(4) The screen voltage for squelch oscillator tube V107 is applied through SQUELCH potentiometer R202 and over the contacts of switch S201. Switch S201, the squelch on-off switch, is mechanically associated with R202. Thus, when R202 is in its extreme counterclockwise position, S201 is open and screen voltage is not supplied to V107.

(5) The plate and screen voltages for second audio amplifier tube V108 are not applied through an internal connection to the 90-volt supply lead. Instead, an external connection (system wiring) is required between terminals H and J of J203, to complete the supply circuit to the plate and screen of V108. The manner in which this connection is made depends on the particular system arrangement.

*c.* When the receiver-transmitter is in the receiving condition, a load extending over normally closed contacts 4 and 5 of O 101, through R136, and the TANK or VEH contact of S201 to ground, is placed across the 90-volt supply circuit. During transmission, when relay O 101 is energized, contacts 4 and 5 of relay O 101 open and disconnect the load. The purpose of the load connection is to insure that the drain on the 90-volt supply is the same under both conditions of operation of the set. Equalization of current drain is important only when a vibrator power supply is used to supply the plate and screen voltages. This condition prevails when the receiver-transmitter is used in conjunction with AF Amplifier AM 65/GRC and Power Supply PP 281/GRC and a 12-volt storage battery, PP 282/GRC and a 24-volt storage battery, or PP 448/GR and a 6-volt storage battery. When the receiver-transmitter is powered from dry batteries, equalization of power supply load is unimportant, whereas saving of battery drain is a major consideration. Under such conditions, the load circuit is disconnected by contacts of switch S101 in the FIELD position.

## 42. Filament Circuits

(figs. 32 and 33)

*a.* The filaments of the tubes in the receiver-transmitter are arranged in three main groups, as follows:

(1) One group includes all filaments which are energized by direct connection to the filament supply lead, terminal F of J203. The 32- to 43.4-mc oscillator tube, V2, and transmitter mixer tube V4 on the RF chassis, and audio amplifier tubes V106 and V108 on the IF chassis belong in this group.

(2) A second group of filaments includes those tubes which are energized over the normally closed contacts of relay O 101. Calibrate oscillator tube V7, receiver tubes V8 through V11 on the RF chassis receiver tubes V101 through V105, and squelch oscillator tube V107 on the IF chassis belong in this group. The calibrate oscillator, the squelch circuit, and all the receiver tubes except the audio amplifier tubes are turned off during transmission.

(3) A third group of filaments includes those tubes which are energized when normally open contacts 2 and 3 of relay O 101 close when relay O 101 is energized. Transmitter tubes V1, V3, V5, and V6 belong in this group. Thus, all transmitter tubes, except the 32- to 43.4-mc oscillator and the transmitter mixer, are deenergized during reception.

*b.* In Receiver-Transmitter RT 70/GRC, the filaments in each group are arranged in several 6-volt series-parallel strings, as shown in figure 32. Isolating chokes and filter capacitors are used throughout to prevent RF currents in one stage from entering tubes in the same or associated strings. Voltage-dropping resistor R117 is inserted, in series

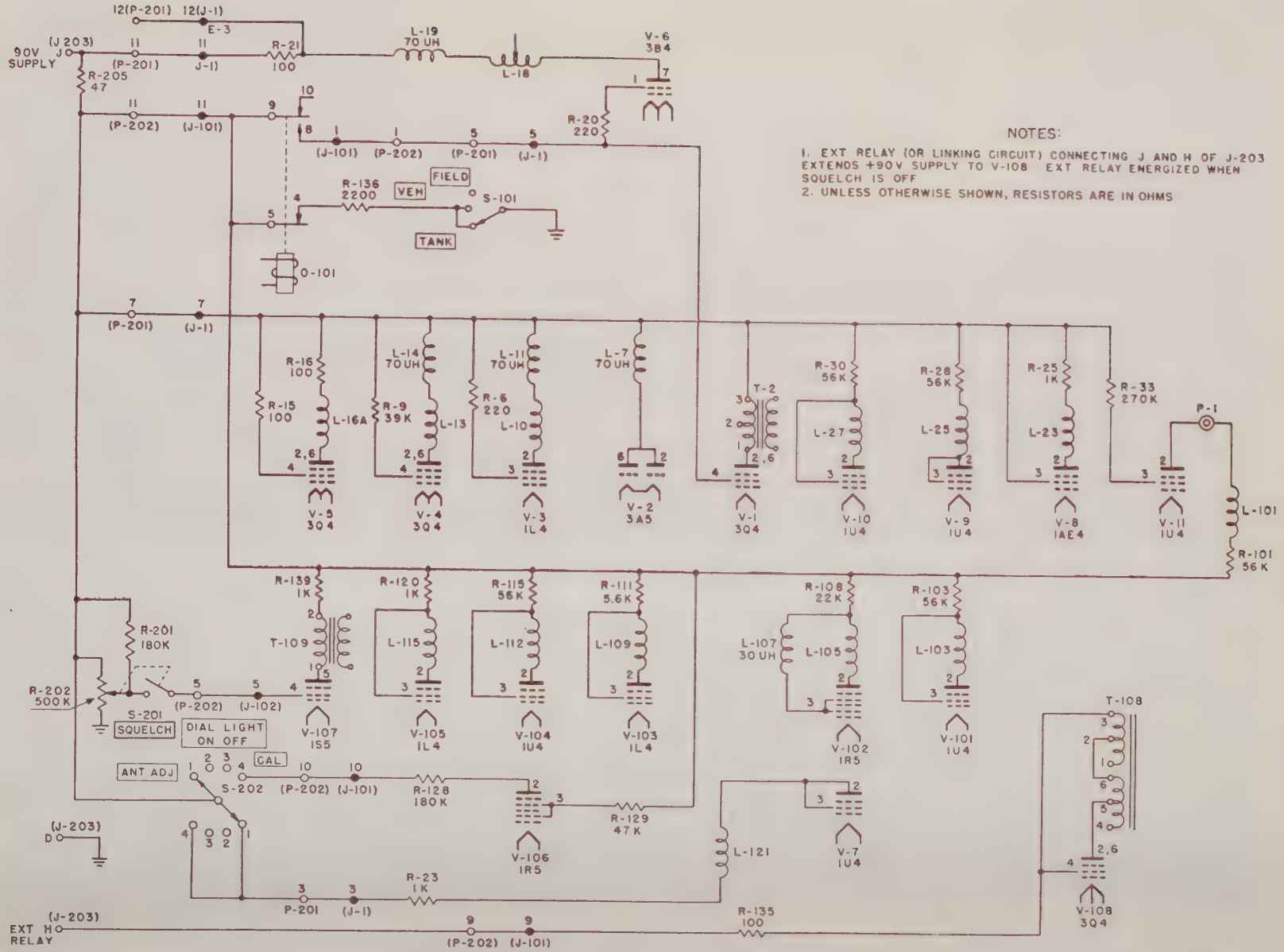


*Figure 31. Plate and screen supply circuits, functional diagram.*

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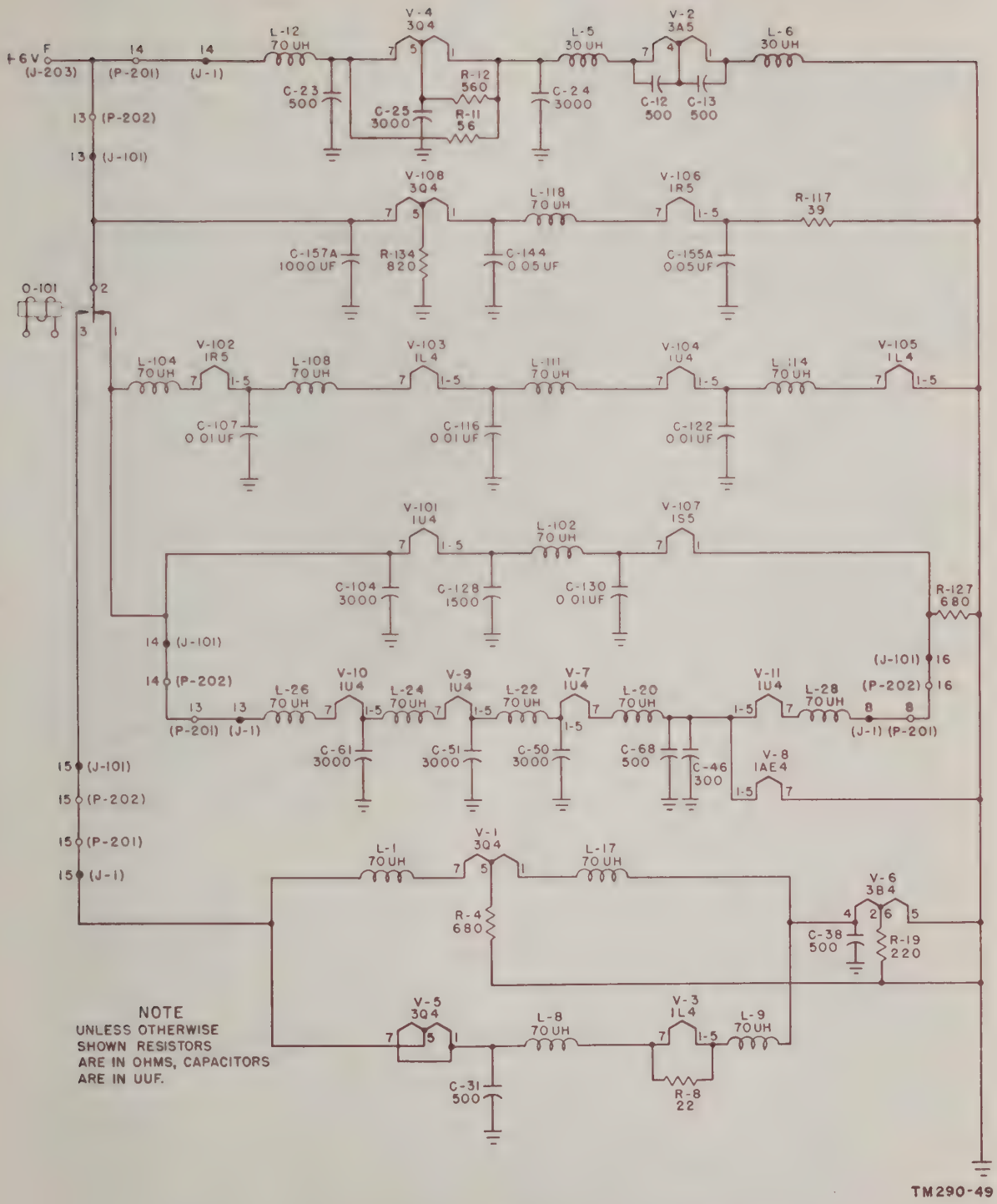



*Figure 32. Receiver-Transmitter RT–70/GRC, filament circuits, functional diagram.*

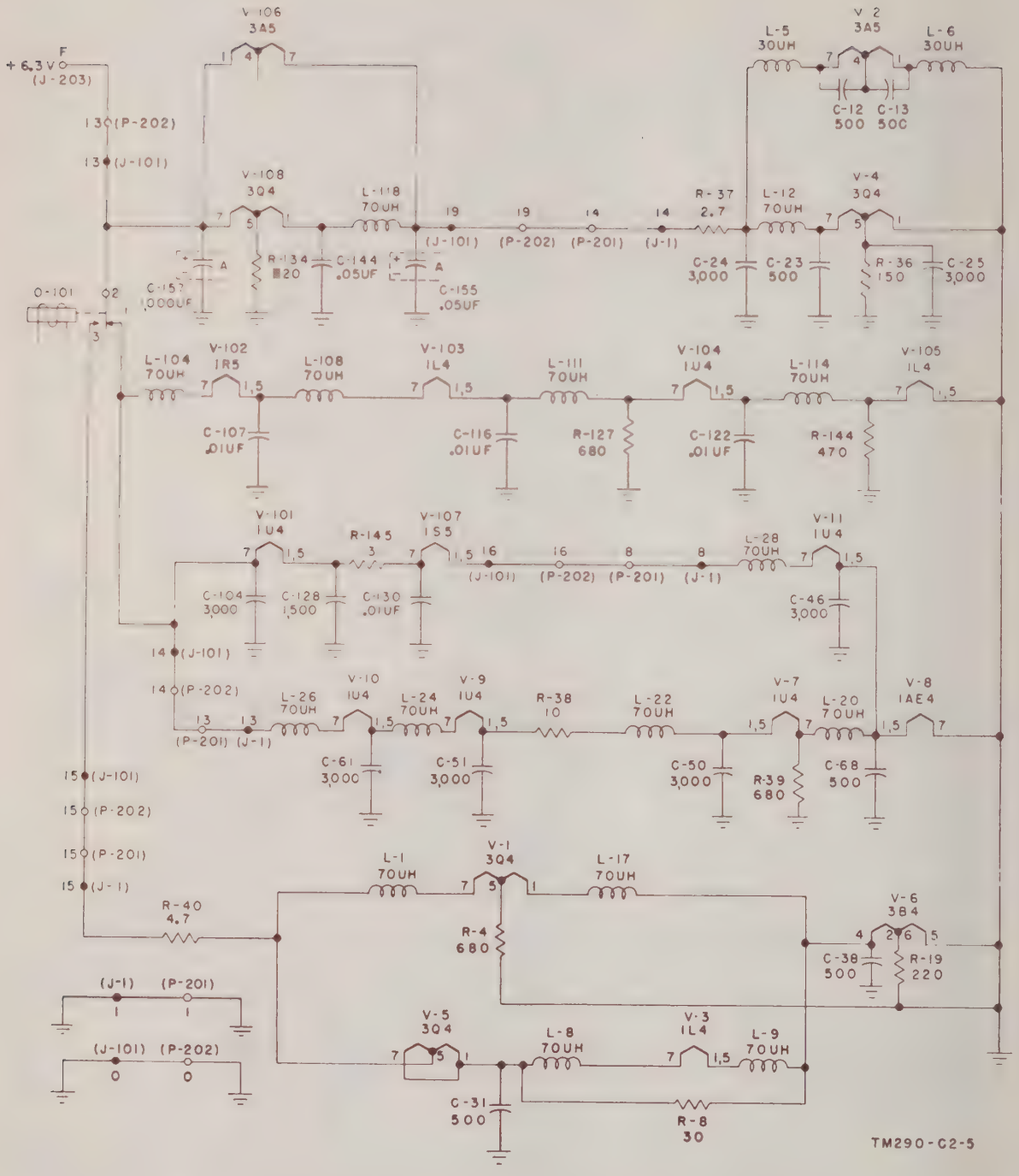



*Figure 33. Receiver-Transmitter RT-70A/GRC, filament circuits, functional diagram.*

with the string of filaments which includes V106 and V108, to bring the total voltage rating of the string to 6.3 volts. Current limiting resistors R11, R12, R8, R134, R127, R4, and R19 are shunted across individual filaments and groups of filaments which draw less current than other filaments in the string. These shunt resistors serve to limit the filament current of relatively low-drain tubes to the required value.

*c.* In Receiver-Transmitter RT–70A/GRC (fig. 33), voltage-dropping resistor R37 is inserted in series with the string of filaments that includes V106, V108, V2, and V4, to limit the voltage available to the tube filaments. Resistors W145, R38, and R40 have been added to the other series-parallel filament strings to perform similar functions there. Current limiting resistors R4, R8, R19, R36, R39, R127, R134, and R144 are shunted across individual filaments and groups of filaments which draw less current than other filaments in the same string. These resistors thus serve to insure that the proper voltage drop appears across each filament in the series-parallel strings.

## 43. Dial Light Circuit

*a.* The dial light circuit is shunted across the filament supply lead by contacts of ANT ADJ-DIAL LIGHT (ON-OFF)-CAL switch S202 in either one of the three positions, ANT ADJ, DIAL LIGHT ON, or CAL (fig. 30). For any one of these switch positions, the circuit extends from terminal F to J203, through voltage-dropping resistor R206, over contact 1, 2, or 4 of switch S202A, through lamp E201 to ground.

*b.* When switch S202 is in the DIAL LIGHT OFF position, the lamp is disconnected from the circuit. The circuit then extends from terminal F of J203, through voltage-dropping resistor R206, through contact 3 of S202A, through dummy load resistor R137 to the TANK contact of switch S101. When switch S101 is set in the TANK position, this circuit is continued to ground. When S101 is in either the VEH or the FIELD position, this circuit is open. Resistor R137 represents a dummy load on the filament supply circuit equivalent to that presented by the dial light, insuring a practically constant drain on the filament supply. When the receiver is used in installations in which current drain, rather than load equalization, is a prime factor the dummy load is not used.

*c.* The purpose of the dial light is to illuminate the dial whenever the receiver transmitter is to be tuned. Also, it serves the auxiliary purposes of indicating that the calibrate and beat oscillators are turned on, and the filament supply circuit at the point of its entry into the receiver-transmitter is continuous. In operation within a system installation, the fact that the dial light goes on when S202 is in any one of the three positions mentioned above, may be used as an indication that the filament supply is reaching Receiver-Transmitter RT–70(*)/GRC.

# CHAPTER 3

# FIELD MAINTENANCE

## Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

### 44. Extent of Instructions

Troubleshooting at a field maintenance level includes all of the techniques outlined for organizational maintenance (as described in TM 11-284) and any other techniques that may be required to isolate a defective part. The systematic troubleshooting procedure consists of sectionalizing, localizing, and isolating sources of trouble within the equipment. Instructions in paragraphs 45 through 80 give procedures for troubleshooting, repair, alinement, and final testing of Receiver-Transmitter RT-70(*)/GRC.

### 45. Troubleshooting Procedures

The test procedures for sectionalizing and localizing trouble in Receiver-Transmitter RT-70(*)/GRC are outlined as follows:

*a. Short-Circuit Checks.* These checks consist of resistance measurements at the terminals of the panel connectors. They are intended to locate the circuits which might damage the power supply or cause additional damage to the equipment when power is applied (par. 47). Repair all short circuits before applying power to the unit.

*b. Current Drain Check.* By measuring the overall plate and filament current drains, the general condition of the receiver-transmitter is determined. This also checks points to defective tube filaments and plate and screen supply circuits (par. 51).

*c. Operational Checks.* The operational checks for the receiver (par. 53) and for the transmitter (par. 55) are made to determine whether or not the receiver-transmitter performs its various functions properly. Facilities available from the front panel are utilized for this purpose. The trouble symptoms thus obtained will point to a fault condition within the receiver or within the transmitter and, in some cases, may sectionalize the trouble to smaller circuit groups or stages. It is recommended that the operational checks be made in the order given, and that each trouble be cleared as it is found before proceeding with the next operational check. Every time a fault condition is encountered, the additional checks recommended in the chart should be made. Detailed instructions for using the operational check charts are given in paragraph 52.

*d. Additional Trouble Sectionalization Checks.* Trouble sectionalization charts for the receiver and for the transmitter (pars. 54 and 56), supplement the operational checks. When trouble is encountered as a result of an operational check, refer to the indicated chart and perform the additional checks. These checks will narrow down the trouble possibilities to a related group of stages or to an individual stage or part. A brief description of the charts follows.

(1) *Receiver trouble sectionalization chart.* After the trouble has been traced by operational checks to the receiver circuit, the tests indicated in the receiver trouble sectionalization chart (par. 54) will isolate the trouble to one of the following circuit sections:

(*a*) Audio circuits.

(*b*) 1.4-mc IF amplifier-limiter stages including the discriminator.

(*c*) 15-mc IF amplifier including receiver first mixer.

(*d*) Receiver RF amplifier circuits.

*Note.* Troubles in the squelch, calibrate and beat oscillator circuits can be narrowed down by means of these circuit checks.

(2) *Transmitter trouble sectionalization chart.* The transmitter trouble sectionalization chart (par. 56) indicates a series of checks for functionally grouped transmitter circuits. The checks indicated in this chart will make it possible to limit the trouble to a particular transmitter stage.

*e. Signal Substitution.* Once the trouble within the receiver-transmitter has been sectionalized to a particular circuit, a signal substitution or signal tracing procedure (par. 57) is utilized to localize the trouble to a specific stage within the group of stages found to be faulty. The stage gain chart will assist in making the signal substitution tests.

*f. Voltage Measurements.* Voltage measurements are made to determine whether the correct dc voltages are present at significant points. They are made for the purpose of locating faults not observable during the preceding tests.

*g. Resistance Measurements.* These tests are made to locate faulty or defective components and wiring within the circuit or stage shown to be defective by the signal tracing procedure.

*h. Additional Checks.* Faults resulting in reduced performance of the equipment not easily discoverable by the preceding tests, are traced by a group of overall equipment performance tests listed under additional checks.

## 46. Test Equipment and Tools Required for Troubleshooting

The following test equipment and tools are required for making the troubleshooting tests described in this section. References are assigned to signal generators and meters listed below to facilitate identifying instruments called for in troubleshooting procedures.

*a.* Any one of the following power supply combinations:

(1) A 6-volt storage battery, Power Supply PP–448/GR and AF Amplifier MA–65/GRC.

(2) A 12-volt storage battery, Power Supply PP–281/GRC and AF Amplifier AM–65/GRC.

(3) A 24-volt storage battery, Power Supply PP–282/GRC and AF Amplifier AM–65/GRC.

(4) A set of batteries including a 90-volt plate supply battery and a 6.3-volt filament and relay supply battery. These batteries are used in Case CY–590/GRC.

*b.* Either of the following audio devices:

(1) Handset H–33/PT.

(2) Chest Set Group AN/GSA–6 with Headset Microphone Assembly H–63/U.

*c.* Test instruments as follows:

(1) Electronic Multimeter TS–505/U: dc volt-ohmmeter (M1).

(2) Electronic Multimeter ME–6/U: ac voltmeter (M2).

(3) Multimeter TS–352/U, or equal (M3).

(4) Output Meter TS–585/U, or equal (M4).

(5) Frequency Meter TS–174/U (20 to 250 mc) or equal (M5).

*d.* Electron Tube Test Set TV–7/U (second and third echelons) or Electron Tube Test Set TV–2/U (fourth and fifth echelons).

*e.* Signal generators as follows:

(1) Signal Generator AN/URM–48 (G1).

(2) Signal Generator TS–588A/U (G2).

(3) Audio Oscillator TS–382A/U, or equal (G3).

*f.* Miscellaneous electrical components as follows:

(1) Shunting unit: consisting of .0062-$\mu$f capacitor in series with resistor, 2,700 ohms, ½ watt; complete with test clips.

(2) Capacitor: mica dielectric; .0062 $\mu$f.

(3) Switch, double-pole, single-throw.

(4) Alligator type clips (2 required).

*g.* Antenna equipment as follows: dummy antenna, consisting of a 50-ohm, 1-watt, noninductive type resistor assembly in series with a 0–200 ma RF ammeter. See figures 35 and 36, and instructions in paragraph 50 for the construction of an equivalent dummy antenna.

*h.* Clips and connectors as follows:

(1) Battery clips and leads.

(2) Test Lead Set CX–1331/U.

(3) Cables and connectors, as required for the particular test setup used (pars. 48–50 and figs. 34–36).

*i.* Tools as follows:

(1) Tool Equipment TE–113 (third and higher echelons).

(2) Allen wrenches No. 313 and No. 468 (supplied).

(3) Tube Puller TL–201 (supplied).

(4) Alinement tool for antenna circuit alignment (Sig C stock No. 6Q335–7).

## 47. Checking Key Circuits for Shorts

The checks outlined in this paragraph are to make sure that when power is connected to the receiver-transmitter, a short circuit in the equipment will not cause damage to the parts or to the power supply. Many types of trouble, such as shorted capacitors, faulty relay contacts, etc., may be discovered by means of these tests. Use Multimeter TS–352/U, or equal (M3), to check the resistance between each of the points on connectors J202 and J203 and chassis.

*a.* The points of measurements and the required readings are summarized in table I. For these measurements, power should be disconnected from the equipment and all front panel connections removed. All tubes, crystal, and other pluck-out parts are assumed to be in their proper sockets. For measurements at connector points F of J203 and J of J203, set switches S202 and S101 (internal) as shown in table II. For measurements at all

other connector points, the settings of these switches are immaterial.

*Table I. Panel Connectors Resistance Measurements*

| Test point | Required reading (ohms) | |
|---|---|---|
| | Connector J202 | Connector J203 |
| A | 60–75Ω | 60–75Ω. |
| B | 0 | Infinity. |
| C | 120 | 120. |
| D | ---------- | 0. |
| E | 0 | Infinity. |
| F | Infinity | See table II. |
| H | 0 | Electrolytic capacitor charge. |
| J | Infinity | See table II. |
| K | ---------- | Infinity. |
| L | | |

*Table II. Resistance Measurements Determined by switch settings*

| Test condition | | Required reading (ohms) | |
|---|---|---|---|
| S202 | S101 | Test point F of J203 | Test point J of J203 |
| ANT ADJ | TANK | 8 | 2,200. |
| | VEH | 8 | 2,200. |
| | FIELD | 8 | Electrolytic capacitor charge. |
| DIAL LIGHT ON | TANK | 8 | 2,200. |
| | VEH | 8 | 2,200. |
| | FIELD | 8 | Electrolytic capacitor charge. |
| DIAL LIGHT OFF | TANK | 8 | 2,200. |
| | VEH | 8 | 2,200. |
| | FIELD | 8 | Electrolytic capacitor charge. |
| CAL | TANK | 8 | 2,200. |
| | VEH | 8 | 2,200. |
| | FIELD | 8 | Electrolytic capacitor charge. |

*b.* If a required reading is not obtained, refer to figures 53 and 54 to determine the part or parts which may be responsible for the trouble. Incorrect readings may be due to shorted or leaky bypass capacitors, defective relay contacts, resistors, or a wire or a lug shorted to the chassis. Check each capacitor in the affected circuit section for leakage or short, and replace, if necessary. Check the wires, lugs on components, and contacts of switches. Repair as necessary. Do not apply power until the trouble has been cleared and all the readings indicated in the table are obtained.

*c.* A guide in interpreting the results of the short-circuit checks may be found in (1) through (3) below. Only a few typical cases are covered here.

(1) The resistance measurement from H of J203 to ground should show a capacitor charge. The rate of charge depends upon the time constant provided by C156A and R135, and upon the resistance of the meter used for making the measurement. If a high resistance meter is used, the meter will show a slow charge and the meter pointer will gradually creep up to some finite reading. However, if immediately upon application of the test probes the meter indicates a low steady reading, capacitor C156A is leaky or shorted, and a breakdown may occur when full power is applied to the equipment.

(2) The readings between terminal C of J202 (or J203) and chassis involve winding 6–7 of T1, resistor R1, the transmitter filament circuits (including the isolating choke coils), the filaments of the tubes (fig. 27), and the bypass capacitors in the filament circuits. In effect, the filament circuits involved here are paralleled by capacitor C157B. The reading obtained depends not only on the condition of C157B but also upon the particular portion of the filament circuit. Thus, if C157B is shorted, the reading will show simply the resistance of T1, winding 6–7. Variations from the correct reading will be obtained, depending upon the location of the fault. In any case, if a very low resistance reading (close to the resistance value of winding 6–7 of T1) is obtained, do not apply power until the fault is traced and remedied.

(3) Readings at terminals F and J of J203 depend upon the settings of switches S202 and S101. Examine the circuit arrangement resulting from the particular settings of these switches before interpreting readings deviating from those shown in table II.

## 48. Test Setup for Operational and Troubleshooting Checks

(fig. 34)

In this paragraph, the procedures are described for preparing and connecting the test installation required for making the operational, troubleshooting, and final tests discussed in this chapter. The procedures for preparing special items such as connecting cables and dummy antenna load, are described in paragraphs 49 and 50. The procedures for making the test setup connections to the panel

connectors are summarized in figure 34. Internal connections for meters, test signal generators, shunting units, etc., are to be made as called for in individual test procedures. Figure 34 shows two basic arrangements for connecting power and audio devices to the receiver-transmitter under test. In one arrangement, power for operating the set may be obtained from dry batteries installed in Case CY–590/GRC. In the other arrangement, power is obtained from a storage battery through a vibrator type power supply unit (Power Supply PP–448/GR, PP–281/GRC, or PP–282/GRC) installed in AF Amplifier AM–65/GRC. The connection of the audio devices or corresponding meters and test signal generator depends on whether or not a plug is available to mate with the 9-pin AUDIO connector on the receiver-transmitter panel. The test connections are described in *a* and *b* below for the two cases.

*a. Case CY–590/GRC.* If dry batteries and Case CY–590/GRC are to be used to provide power to the equipment, proceed as follows:

(1) *Power connections.*

(*a*) Make sure that 90-volt and 7.5-volt batteries are installed in the case.

(*b*) Make sure that the ON-OFF-REMOTE switch in the case is, at this time, in the OFF position. This switch will be used as a power on-off switch for the test setup.

(*c*) See that the plugs on the battery cable within the case are properly connected to the battery sockets.

(*d*) Connect Power Cable Assembly CX–1209/U (complete with connectors) between POWER connector J203 on the receiver-transmitter panel and 14-pin connector J1 on Case CY–590/GRC.

(2) *Audio devices.* The audio devices (microphone and earphone or audio signal generator and test meter) may be connected either to the AUDIO connector on the receiver-transmitter panel or as shown in figure 34 to 9-pin connector J2 on Case CY–590/GRC.

(*a*) If a 10-pin male compression type connector is available to mate with the receiver-transmitter AUDIO connector, connect the audio devices to the cable as described in paragraph 49*a* and connect the assembly to the AUDIO connector on the receiver-transmitter panel.

(*b*) If the above connector is not available for the cable, connect the audio device to the cable as described in paragraph 49*b* and connect the assembly to 9-pin connector J2 on Case CY–590/GRC.

(3) *Dummy antenna load.* Prepare the dummy antenna load as described in paragraph 50 and plug it into the ANT connector on the front panel of the receiver-transmitter.

*b. Vibrator Type Power Supply.* If power is to be derived from the storage battery through a vibrator power supply unit, proceed as follows:

(1) *Power connections.*

(*a*) See that the voltage of the storage battery, the voltage rating of the power supply unit, and the rating of the fuse installed in the fuse holder within AF Amplifier AM–65/GRC all agree. Refer to the table on figure 34.

(*b*) Make sure that the 6V–12V–24V switch within the amplifier unit is set to the position corresponding to the voltage of the storage battery used.

(*c*) Make sure that the OFF–INT–RT–70 switch on the panel of the amplifier unit is in the OFF position at this time. This switch will be used as the power on-off switch for the receiver-transmitter. For this purpose, the switch position marked RT–70 is, in effect, the ON position for power applied to the receiver-transmitter. The INT position applies power to the amplifier unit only

***Caution:*** Never turn the OFF-INT-RT–70 switch to the RT–70 position unless the receiver-transmitter is connected to the amplifier.

(*d*) Install the vibrator power supply unit in AF Amplifier AM–65/GRC.

(*e*) Connect the positive (+) terminal of the storage battery to terminal A of the POWER IN connector on the front panel of the amplifier unit. Connect the negative (−) terminal of the battery to terminal C (ground) of that connector. If a battery cable fitted with battery clips or lugs at one end and a 4-pin male connector to mate with the POWEW IN connector on the amplifier at the other end is not available, the cable may be made up as described in paragraph 49*c*.

(*f*) Prepare a power cable as described in paragraph 49*d* (power leads shown in figure 34, with a 9-pin connector—male plug-in type terminals—at each end) and connect it between the POWER connector on the receiver-transmitter and the RT–70 POWER connector on the amplifier unit.

(2) *Audio connections.* The audio devices (microphone and earphone or audio signal generator and meter) may be connected to either the AUDIO connector on the front of the receiver-transmitter directly, or the audio terminals of the POWER connector on the receiver-transmitter panel, depending upon whether or not the 10-pin compression type male connector is available.

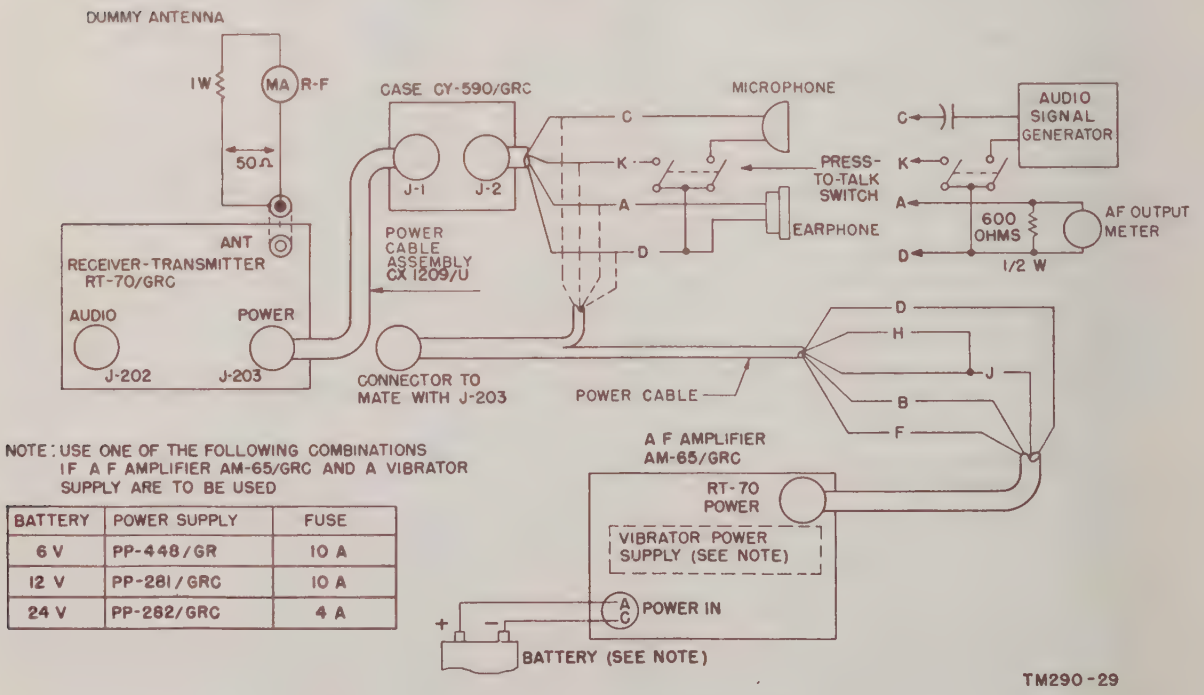
(*a*) If a 10-pin connector (with male compression type terminals) is available, arrange the cable as described in paragraph 49*a* and attach the assembly to the AUDIO connector on the receiver-transmitter.

(*b*) If such a connector is not available, the paralleling audio connections brought to the POWER connector within the receiver-transmitter will have to be utilized to make the audio connections. In this case, the leads from the audio devices will be connected to the audio terminals of the 9-pin male plug-in type connector on the power cable from the amplifier and the combination plugged into the receiver-transmitter POWER connector. Details for forming that cable are described in paragraph 49*d*.

(3) *Antenna connections.* Prepare the dummy antenna as described in paragraph 50 and connect to the ANT connector on the front panel of the receiver-transmitter.

## 49. Preparation of Test Cables

*a. Cable for Attachment to Audio Connector on Receiver-Transmitter.* Use a 10-pin audio connector (male compression type terminal). Cut lead lengths so that the resultant cable will permit turning the unit under test to any desired position. Since both the headset and microphone and the test signal generator or the AF output meter are called for in the test, it may be desirable either to prepare two separate cables or to insert switches in the cable leads to permit interchanging the meter and generator for headphones and microphone, respectively, as called for in the particular test. Make the following connections:




NOTE: USE ONE OF THE FOLLOWING COMBINATIONS IF A F AMPLIFIER AM-65/GRC AND A VIBRATOR SUPPLY ARE TO BE USED

| BATTERY | POWER SUPPLY | FUSE |
|---|---|---|
| 6 V | PP-448/GR | 10 A |
| 12 V | PP-281/GRC | 10 A |
| 24 V | PP-282/GRC | 4 A |

*Figure 34. Test setup for operational and troubleshooting checks.*

(1) Connect the cable carbon element of the microphone in series with one set of contacts of the microphone push-to-talk switch (or the AF signal generator in series with one section of a dpst switch) between terminals C and E (ground) of the cable connector.

(2) Connect the other set of contacts of the microphone push-to-talk switch (or second section of dpst switch) between terminals F and B (ground) of the cable connector.

(3) Connect the headphones (or AF output meter M5 shunted by a 600-ohm, ½-watt resistor) between terminals A and H (ground) of the cable connector.

*b. Audio Cable for Attachment to Case CY–590/GRC Connector J2.* If connection is to be made through connector J2 on Case CY–590/GRC, a 9-pin connector (male plug-in type terminal), suitable for attachment to the J2 connector on the case, is required. Make the following connections:

(1) Connect the carbon element of the microphone in series with one set of push-to-talk contacts (or the AF signal generator through one set of dpst switch contacts) between terminals C and D (ground) of the cable connector.

(2) Connect the other set of the push-to-talk contacts of the microphone (or dpst switch) between terminals K and D of the cable connector.

(3) Connect the headphone (or AF output meter M5 shunted by 600 ohms) between terminals A and D of the cable connector.

*c. Battery Cable.* The cable for connection between the storage battery and the POWER IN connector on AF Amplifier AM–65/GRC, if used for providing power to the receiver-transmitter, requires the use of a 4-pin connector (male plug-in type terminal) suitable for attachment to the POWER IN connector on the amplifier panel. In addition, a set of battery clips is required to permit connection of the cable to the battery.

(1) If a formed battery cable is not available, cut two lengths of No. 12 gage heavily insulated wire. Trim the insulation and solder one lead to a clip at one end and to terminal A of the cable connector at the other.

(2) Solder one end of the other lead to a spring clip and the other end to terminal C (ground) of the connector. Make sure that the ends of the cable are properly insulated to prevent short circuits.

*d. Power Cable.* This power is used for connection between the RT–70 POWER connector on AF Amplifier AM–65/GRC and the POWER connector on the receiver-transmitter panel. Two 9-pin connectors (male plug-in type terminal) are required.

(1) Connect No. 16 gage leads between terminal J of the two connectors.

(2) Connect a No. 16 gage lead between terminal B of the two connectors.

(3) Connect a No. 12 gage lead between terminal F of the two connectors.

(4) Connect a No. 12 gage lead between terminal D (ground) of the two connectors.

(5) Connect a strap between terminals J and H of the connector which will attach to the POWER connector on the receiver-transmitter panel. (This strap completes the 90-volt circuit to the receiver second audio amplifier stage. In a system installation, this strap is provided in the mounting or in Case CY–590/GRC.)

*e. Audio Cable for Connection to Receiver-Transmitter Power Connector.* If connection of the audio circuits cannot be made as described in *a* above, then connect the audio devices to the connector on the power cable (*d* above) which will attach to the POWER connector on the receiver-transmitter panel.

(1) Connect the microphone (or AF signal generator) in series with one set of push-to-talk contracts between terminals C and D (ground) of the POWER connector.

(2) Connect the other set of push-to-talk contacts between terminals K and D of the POWER connector.

(3) Connect the headphones (or audio output meter M3 shunted by a 600-ohm resistor) between terminals A and D of the POWER connector.

## 50. Preparation of Dummy Antenna Load (fig. 35)

The dummy antenna load consists of an RF meter in series with a 40-ohm, 2-watt resistor, and terminates in a coaxial cable connector. (The 40-ohm resistor is selected by ohmmeter or bridge measurements from a batch of 39-ohm resistors.) The coaxial connector plugs into the ANT connector on the front panel of the receiver-transmitter. Details for the preparation of the complete assembly are shown on figure 36.

*Figure 35. Dummy antenna load, front and side views.*

## 51. Overall Plate and Filament Current Drain Check

*a. Test Procedure.* The purpose of this check is to determine the overall drain on the plate and filament supplies by the receiver-transmitter. A reduction in overall drain from the values given below shows that a defect exists in the filmaent or plate circuits of the receiver-transmitter. It is a rough check on tubes. Proceed as follows:

(1) Insert a milliammeter with a range of 100 ma dc in the 90-volt supply lead to the receiver-transmitter.

(2) Insert an ammeter with a range of 1 ampere dc in the 6.3-volt filament supply lead.

(3) Turn on power and allow a warm-up period of a few seconds.

(4) Obtain the measurements indicated in *b* below for each of the switch settings of switches S202 and S201. For measurements of receiver current drain, do not press the microphone switch (relay O 101 unenergized). For readings of transmitter current drain, energize relay O 101 by either closing the microphone switch or grounding terminal K of J203 or terminal F of J202. If the required readings are not obtained, perform the operational checks (pars. 52–55).

*b. Receiver-Transmitter RT–70/GRC Current Drain Check Chart.*

| Supply lead | Setting of S202 | Current readings (ma); microphone switch open (receiver on), S101 in in position | | | Current readings (ma); microphone switch closed (transmitter on), S101 position | | |
|---|---|---|---|---|---|---|---|
| | | Tank | Veh | Field | Tank | Veh | Field |
| 90-volt plate and screen supply lead. | ANT ADJ | 77 | 77 | 38 | 79 | 79 | 79 |
| | DIAL LIGHT ON | 77 | 77 | 38 | 79 | 79 | 79 |
| | DIAL LIGHT OFF | 77 | 77 | 38 | 79 | 79 | 79 |
| | CAL | 77 | 77 | 38 | 79 | 79 | 79 |
| 6.3-volt filament supply lead | ANT ADJ | 390 | 390 | 390 | 415 | 415 | 415 |
| | DIAL LIGHT ON | 385 | 385 | 385 | 410 | 410 | 410 |
| | DIAL LIGHT OFF | 385 | 385 | 323 | 410 | 410 | 350 |
| | CAL | 395 | 395 | 390 | 415 | 415 | 415 |

*c. Receiver-Transmitter RT-70A/GRC Current Drain Check Chart.*

| Supply lead | Setting of S202 | Current readings (ma); microphone switch open (receiver on), S101 in position | | | Current readings (ma); microphone switch closed (transmitter on), S101 in position | | |
|---|---|---|---|---|---|---|---|
| | | Tank | Veh | Field | Tank | Veh | Field |
| 90-volt plate and screen supply lead. | ANT ADJ | 65 | 65 | 28 | 68 | 68 | 68 |
| | DIAL LIGHT ON | 67 | 67 | 30 | 68 | 68 | 68 |
| | DIAL LIGHT OFF | 67 | 67 | 30 | 68 | 68 | 68 |
| | CAL | 64 | 64 | 28 | 69 | 69 | 69 |
| 6.3-volt filament supply lead. | ANT ADJ | 380 | 380 | 380 | 364 | 364 | 364 |
| | DIAL LIGHT ON | 380 | 380 | 380 | 364 | 364 | 364 |
| | DIAL LIGHT OFF | 380 | 380 | 320 | 364 | 364 | 305 |
| | CAL | 377 | 377 | 377 | 362 | 362 | 364 |

## 52. Purpose and Use of Operation Check Chart

*a. Purpose.* The operational checks (pars. 52-55) serve as a first step in sectionalizing trouble in the receiver-transmitter. Panel-mounted controls and facilities are used to operate the equipment under as close to normal conditions as possible at the test bench. Facilities such as the thermal noise normally present in an FM receiver, the internal calibrate and beat oscillators, and sidetone are utilized for this purpose. The trouble symptoms determined by these checks, when properly interpreted, will point to specific circuits as being defective and to additional checks necessary to further localize the trouble to a particular stage.

*b. Use.* The tests given in the charts show a certain specific sequence. Each test assumes that the preceding tests have been made and the troubles thus discovered have been eliminated. Accordingly, start with item (1) and proceed in the indicated order. The chart includes several columns as follows:

(1) *Item of check.* This column assigns the numerical sequence to the particular check to facilitate further reference to it, and describes briefly the purpose of each check.

(2) *Test condition or operation.* This column lists the switches and controls to be operated and the conditions to be met. To facilitate identification, meters and signal generators, were called for, are identified with references corresponding to those given in paragraph 46.

(3) *Normal indication.* This column shows what to expect after the test conditions have been met. If these indications are not met as specified, a trouble condition exists. For example, step 1 gives a check of receiver operation based on the presence of noise in the RF and IF circuits. Absence of noise shows that the receiver is defective at some point. Audibility of the noise does not prove conclusively that the entire receiver is functioning properly. The RF stage may be defective and yet noise may be heard in the earpiece. The volume of noise is a function of the total gain of the stages, a defect in the RF and mixer stages of the receiver will show up as a reduction in the volume of noise heard. Proper interpretation of the volume will give a more precise meaning to the normal indication for steps 2 and 3.

(4) *Possible causes of trouble.* This column indicates the circuit sections to be suspected as being defective if the normal indication is not obtained. In cases where several types of trouble symptoms are possible, the circuit sections involved in each type of trouble symptom are listed.

(5) *Further checks.* This column lists the sectionalization or localization checks to be made if the normal indication is not obtained. Where further operational checks are necessary, perform that check. Note the resultant indication and, if abnormal, follow through as indicated in the further checks column for that operational check.

*c. Additional Trouble Sectionalization Data.* The operational check charts are supplemented by sectionalization charts (pars. 54 and 56) which serve to further limit the trouble to a particular stage within the circuit section determined as being defective by the operational checks. The sec-

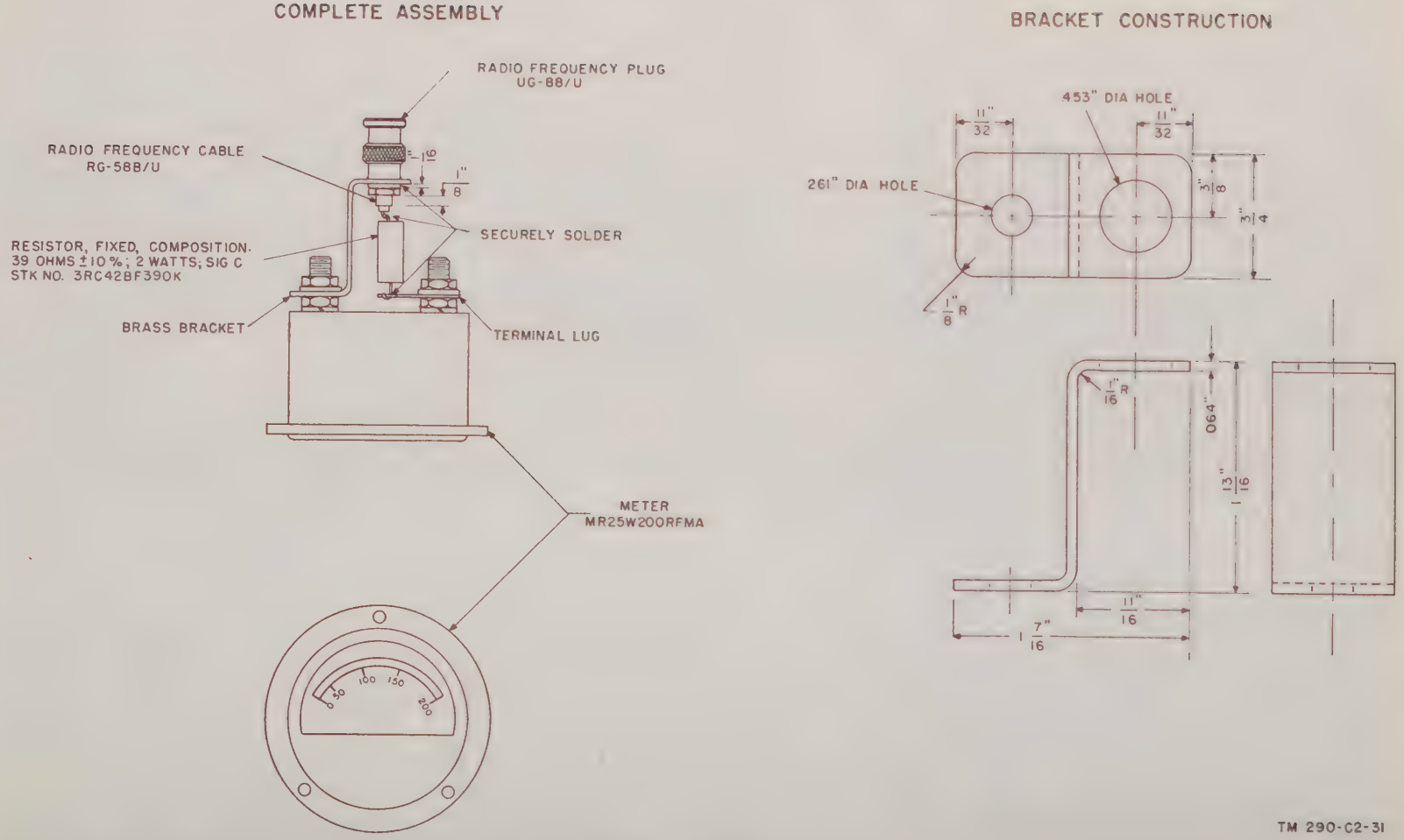



*Figure 36. Construction of dummy antenna.*

tionalization charts for the receiver and transmitter include a column marked test conditions and operation. This column is similar to the one in the operational check chart but since quantitative measurements are made throughout, meters and signal generators are listed. To facilitate identification, these items are assigned references corresponding to those appearing in paragraphs 53 and 55. The nature of the normal indication should serve as a guide in selection of meter ranges and signal generators.

## 53. Receiver Operational Checks

| Item of check | Test conditions and operation | Normal indications | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| Preliminary | See that all tubes and crystals are firmly seated in their sockets. Turn S202 to DIAL LIGHT OFF.<br>Turn S101 to VEH if AF Amplifier AM-65/GRC and a vibrator power supply are used, or to FIELD if dry batteries are used to supply power.<br>Set up Receiver-Transmitter RT-70(*)/GRC as outlined in paragraph 49.<br>Turn SQUELCH control to extreme clockwise position. Turn VOLUME control to extreme clockwise position.<br>Turn on power if Case CY-590/GRC is used, turn the OFF-ON-REMOTE switch in that unit to the ON position.<br>If AF Amplifier AM-65/GRC is used in the test setup, turn the OFF-INT-RT-70 switch on that unit to RT-70 to turn on power. | | | |
| (1) Dial light | Turn S202 to DIAL LIGHT ON. | Dial light goes on | Defective lamp | Check lamp. |
| | | | No power | Check power source. |
| | | | Defective dial light circuit. | Check dial light circuit by point-to-point resistance measurements. |
| (2) Overall receiver operation. | Turn SQUELCH control to extreme counterclockwise position. Listen in headphones. | Rushing noise (assuming no incoming signal) is heard in earphone. | Defective stage in receiver circuit. | See that chassis connectors and coaxial cable connector P1 are properly connected.<br>Proceed with measurements given in trouble sectionalization chart (par. 54). |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (3) | | | | |
| Volume adjustment. | Turn VOLUME control in counterclockwise direction until volume of noise is reduced to suitable listening level. | Volume of rushing noise decreases gradually as control is rotated. | Defective volume control R204, or associated circuit components. | Check R204. |
| (4) | | | | |
| Squelch action. | Turn SQUELCH control in clockwise direction until noise disappears. | Rushing noise disappears abruptly. | Defective squelch (V107) circuit. | Check V107 in a tube checker or substitute a new tube. Check squelch circuit (par. 54, item (15)). |
| (5) | | | | |
| Dial operation. | Lift cranking handle out of its recess on tuning knob and crank to tune from one end of dial to the other and back.<br>Detent levers not set. | Dial rotates smoothly, without scraping, slippage or bumps. | Broken or defective dial-drive cable. | Repair drive cable as described in paragraph 66*g*. |
| (6) | | | | |
| Calibrate oscillator operation. | Turn SQUELCH control to extreme counterclockwise direction (off).<br>Turn S202 to ANT ADJ position.<br>Turn dial until normal indication is obtained. | Rushing noise disappears, or is considerably reduced at some setting of the dial at or near an mc point. | Defective calibrate oscillator V7 circuit. | Check V9. Check circuit components by point-to-point voltage and resistance measurements (pars. 58 and 59). |
| | | | Low receiver gain | Make measurements on receiver RF and IF circuits, as described in paragraphs 54 and 57. |
| | | | Variable oscillator V2 not oscillating or badly misalined. | Touch grid of V2. Noise should be reduced. If not, V2 circuit is defective. |
| (7) | | | | |
| Beat oscillator. | Turn S202 to CAL position. | Rushing noise disappears as beat note is heard at some setting of the dial near an mc position. | Defective beat oscillator. | Check V106.<br>Check beat oscillator circuit as described in paragraph 54, item (6) and paragraph 72*b*.<br>Make appropriate receiver measurements (pars. 54, 57, 58, and 59). |
| (8) | | | | |
| Vernier dial calibration. | Rotate tuning knob so that beat note is heard at any convenient mc point on the dial. | Zero on vernier knob plate lines up with calibration marker on panel. | Vernier knop requires rezeroing. | Rotate vernier plate until zero lines up with marker on panel. Hold knob in place while doing this.<br>This procedure calibrates the channels up to 1 mc above and 1 mc below the calibration point, and will be referred to whenever calibration of a test signal is called for in subsequent checks. |
| (9) | | | | |
| Calibration checks | Rotate dial through its entire tuning range, starting with 58 mc. | At or close to each mc setting of the dial, rushing noise disappears. Beat note is heard. | Variable oscillator not oscillating. | Check grid voltage of V2 (par. 56, item (1)). |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| | Listen in headphones for noise and adjust tuning knob until zero beat is obtained at each mc point (note 1 below). | | Variable oscillator V2 is off frequency, if beat notes occur at points more than 25 kc from mc points. | Check variable oscillator frequency (par. 74*c*(1)). If the calibration error (note 2 below) exceeds 25 kc at 58- and/or 47-mc setting of dial, incorrect alinement of the oscillator is indicated. Realine oscillator (par. 72). |
| (10) | Rotate dial through its entire tuning range. | Volume of noise is about the same in intensity for all mc settings of the dial. | If level of noise drops off considerably as one end of dial is approached, the gain at that end of the band is too low. | Check stage gain (par. 57). |

*Notes.* 1. The pitch of sound in the headphones will be higher as the knob is rotated in either direction away from a zero beat position. This fact should be noted to make sure that what is presumed to be zero beat is not in reality silence due to absence of a signal or a note too high in pitch to be audible.
2. The term *calibration error* is taken to mean the amount by which the center point zero is away from the calibration marker on the panel, when the zero beat is obtained.

## 54. Receiver Trouble Sectionalization Checks

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| Preliminary | S202 in DIAL LIGHT OFF position.<br>SQUELCH control in OFF position.<br>VOLUME control in extreme clockwise position. | | | |
| (1)<br>Audio amplifier circuit gain. | Connect audio signal (G3) between test point E106 and chassis.<br>Adjust frequency to 1,000 cycles and level to .45 volt.<br>Connect meter (M4) between terminals A of J202 or J203 and chassis. | AF output meter (M4) indicates 80 mw. | Defective audio amplifier stage V106 or V180. | Make individual stage gain measurements (par. 57).<br>Check tube of stage (V106 or V108) shown to give low or no output.<br>Make point-to-point resistance measurements of stage shown to be defective (par. 58). |
| (2)<br>Determine equivalent limiter meter reading. | Connect 1.4-mc test signal generator (G1) through a .01-$\mu$f capacitor between E103 and chassis.<br>Connect meter (M1) between E104 and chassis.<br>Tune receiver to a point between mc positions of the dial (to keep calibrate oscillator signal out of circuit).<br>Adjust test signal frequency to zero beat with beat oscillator (1.4-mc). Adjust test signal level to .15 volt. | Meter (ML) should indicate about -1.4 volts. | | Record the reading thus obtained. This reading will be referred to as *reference A*. In subsequent measurements, the test signal level will be adjusted to obtain this reference reading. The test signal level required to obtain this reading will be taken as a measure of the gain of the circuit or stage being measured. |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (3)<br>1.4 mc if amplifier limiter stages overall gain measurements. | Connect limiter meter (M1) to E104 and chassis.<br>Connect 1.4-mc test (G1) signal (unmodulated) through .01-μf capacitor and chassis.<br>Zero beat the test signal with the beat oscillator.<br>Adjust the 1.4-mc test signal level to obtain *reference A* (item (2)). | 2,600 microvolts (approx) for −1.4 volts. | (*a*) Defective if amplifier V104 stage (V102 through V104). | (*a*) Check gains of individual stages V102 through V104 (par. 57).<br>Check tube of stage showing low or no output.<br>Make point-to-point voltage and resistance measurements (pars. 58 and 59) of stage with low or no output.<br>Check alinement of 1.4-mc IF circuits if above procedures fail to reveal causes of trouble. |
| | Measure the test signal level when reference reading is obtained. | | (*b*) Excessive gain reading may indicate regeneration. | (*b*) Check filament bypass capacitors. |
| (4)<br>Receiver second mixer stage. | Connect 15-mc test signal generator (G1) (unmodulated) through .003-μf capacitor between E101 and chassis.<br>Connect limiter meter (M1) to E104.<br>Zero beat test signal with test oscillator.<br>Adjust level to obtain *reference A* on limiter meter.<br>Measure test signal level when reference reading is obtained. | 5,200 microvolts (approx) for −1.4 volts. | (*a*) Defective second mixer stage.<br>(*b*) Defective second mixer oscillator (part of V102). | (*a*) Check V102.<br>Make point-to-point voltage and resistance measurements on V102 circuits (pars. 58 and 59).<br>(*b*) See item (5) below. |
| (5)<br>Second mixer oscillator. | Disconnect test signal generator.<br>Use M1 to make the following measurements.<br>Between pin 4 of V102 and chassis. | −.8 to −2.0 volts (approx). | (*a*) Defective Y101 crystal.<br>(*b*) Defective V102.<br>(*c*) Defective circuit component. | (*a*) Try replacing with another crystal.<br>(*b*) Check tube V102.<br>(*c*) Make point-to-point voltage and resistance measurements (pars. 58 and 59). |
| (6)<br>Beat oscillator check. | Set S202 to CAL. Disconnect test signal from equipment.<br>Use M1 to measure voltages at the following points: | | | |
| | (*a*) Pin 2 of V106 | (*a*) +45 volts. | | |
| | (*b*) Pin 6 of V106 | (*b*) −2.5 volts (approx). | Defective crystal Y012 | Try replacing crystal. |
| | | | Defective V106 | Check tube V106. |
| | | | Defective circuit component. | Make point-to-point resistance and voltage measurements on oscillator circuit components associated with V106 (pars. 58 and 59). |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (7) Beat oscillator check (RT-70A/GRC). | Set S202 to CAL. Disconnect test signal from equipment. Use M1 to measure voltages at the following points: | | | |
| | (*a*) Pin 2 of V106 | (*a*) +22.5 volts. | | |
| | (*b*) Pin 3 of V106 | (*b*) −.6 volt | (*b*) Defective Y102.<br>Defective V106<br>Defective circuit component. | Replace crystal.<br>Check tube V106.<br>Make point-to-point resistance and voltage measurements on oscillator circuit components associated with V106 (pars. 58 and 59). |
| (8) Discriminator | 1.4-mc test signal at (G2) .15-volt rms applied between E103 and chassis. | 0 +.5 volt. | | |
| (*a*) Alinement | Connect M1 between E106 and ground. | | (*a*) Defective V105<br>(*b*) Defective circuit components of V105.<br>(*c*) Misalined discriminator circuit. | (*a*) Check V105.<br>(*b*) Check resistances in V105 circuits (par. 58).<br>(*c*) Check alinement of discriminator circuit (T106) (par. 72). |
| (*b*) Baiance | (*a*) Change test signal frequency to 1.43 mc (G2). | (*a*) +5 volts minimum for all RT-70A/GRC's and for RT-70/GRC's on Order No. 2884-Phila-52; +6 volts, min for all other RT-70/GRC's. | Defective CR101 or CR102, or coil L116 or L117. | The two readings should be of opposite polarity and numerically equal to each other, within .2 volt. If this requirement is not met, realine T106. If this cannot be accomplished, check circuit components. |
| | (*b*) Change test signal frequency to 1.37 mc (G2). | (*b*) −5 volts minimum RT-70A/GRC's for RT-70/GRC's on Order No. 2884-Phila-52; −6 volts, min for all other RT-70/GRC's. | | |
| (9) 15-mc IF amplifier circuits, gain measurements. | Connect limiter meter M1 to test point E104.<br>Connect signal generator G1 through a .003-$\mu$f capacitor, between pin 6 of V10 and chassis.<br>Adjust the test signal frequency for zero beat with beat oscillator (item 2).<br>Adjust test signal level to obtain *reference A*.<br>Measure test signal level. | 12 microvolts (approx) | (*a*) Defective IF amplifier stage V10, V11, or V101. | (*a*) Check gains of individual stages, V10, V11, and V101 (par. 57).<br>Check alinement of 15-mc IF amplifier circuits (par. 72).<br>Check tube of stage showing low or no output.<br>Make point-to-point voltage and resistance measurements of stage with low or no output (pars. 58 and 59). |
| | | | (*b*) Excessive gain readings may indicate regeneration. | (*b*) Check filament bypass capacitor. |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (10)<br>*Reference B* indication for 15-mc IF and RF circuit measurements. | Raise test signal level until second limiter grid meter (M1) indicates −11 volts dc. Determine test signal level. Measure test signal level. | 150 microvolts (approx). | Same as in item (9) above. | Same as in item (9) above. *Note.* This step serves to establish a new limiter grid reference level sufficiently above the noise level to make accurate readings possible. Hereafter, this reading will be called *reference B*. |
| (11)<br>Gain of receiver first mixer V9. | Shift generator connection to grid (pin 6) of V9. Adjust signal generator level to obtain *reference B* reading (−11 volts) on limiter meter.<br>Measure test signal level | 24 microvolts (approx). | (*a*) Improper alinement.<br>(*b*) Defective V9.<br>(*c*) Defective circuit components of mixer stage. | (*a*) Check alinement of T9 (par. 72).<br>(*b*) Check V9.<br>(*c*) Check circuit components by point-to-point resistance and voltage measurements (pars. 58 and 59). |
| (12)<br>Gain of receiver RF stage V8. | Connect RF signal generator (G20) through a 500-μμf capacitor between pin 6 of V8 and chassis. | ---------- | Improper alinement.<br>Defective V8. | Check alinement of T8 (par. 72).<br>Check tube V8. |
| | (*a*) Adjust frequency to 58 mc. Tune in with receiver dial. Adjust level to obtain *reference B* readings on limiter meter. | (*a*) 7 microvolts (approx). | Defective circuit component for stage. | Make point-to-point resistance and voltage measurements (pars. 58 and 59). |
| | Determine signal generator output level required to obtain *reference B*. | . . . . . | Output of variable oscillator V2 too low. | Check grid voltage of V2 (par. 56, item (1)).<br>Check alinement of V2 stage (par. 72). |
| | (*b*) Adjust test frequency to 47 mc, tune in on receiver. Adjust signal input level to obtain *reference B* reading on limiter meter.<br>Determine test signal input level required to obtain that reading. | (*b*) 15 microvolts (approx). | | |
| (13)<br>Receiver RF circuits. | Connect RF signal generator (G2) to ANT connector. Make leads as short as possible. | | | |
| (*a*) Antenna trimmer (C41) adjustment. | (*a*) Adjust test frequency to 58 mc, and tune in with dial.<br>Adjust test signal level to give *reference B* limiter meter reading.<br>Tune receiver for maximum deflection of limiter meter (M1).<br>Adjust trimmer capacitor C41 for max deflection of M1. Readjust signal level to obtain *refer-* | 8 microvolts (approx) | Defective antenna circuit. | Check antenna circuit components for defects. |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| | *ence B* reading on limiter meter. Determine test signal input level. | | | |
| (*b*) Antenna inductance adjustment. | (*b*) Change test signal frequency to 47 mc. Tune in with dial. Do not adjust C41. Adjust test signal level to obtain *reference B* reading on limiter meter. Determine test signal level. | 1.6 microvolts (approx). | Inductance of L18 incorrect. | Adjust the inductance of L18. This is done by detaching the IF chassis to gain access to RF coil box, and spreading or squeezing the turns of L18, as required. Coil L18 is accessible through slot in RF coil compartment. For adjustment details, see paragraph 72. |
| (14) Discriminator checks. | Apply an RF 1.0-microvolt signal modulated at 1 kc with ± 15-kc deviation to ANT connector (use G2). Set VOLUME control to max clockwise position. Set SQUELCH control to max counterclockwise position. Turn S202 to DIAL LIGHT ON (or OFF). Adjust test signal frequency to suitable frequency (58 mc). Tune in with dial knob. Using output meter M4, measure power output level across A and B of J202. Use a 600-ohm load. | Meter should indicate 80 milliwatts (approx). | (*a*) Improper alinement of discriminator.<br>(*b*) Reduced discriminator output.<br>(*c*) Low output of V105. | (*a*) Check alinement (par. 72).<br>(*b*) Check stage gains (par. 57).<br>(*c*) Check V105, and associated circuit components. |
| (15) Squelch circuits operation (for all RT-70(*)/GRC's except those on Order No. 2884-Phila-52). | (*a*) VOLUME control in max clockwise position. SQUELCH control in OFF position. Apply test signal at 58 mc with 1-kc modulation at ±15-kc deviation (G2) and at a level of 1 microvolt to ANT connector. Tune in signal with dial. Reduce test signal level to zero. Gradually advance SQUELCH control in clockwise direction. Increase G2 output until some noise reappears. Check G2 output level. | (*a*) Noise disappears abruptly at some setting of SQUELCH control. Signal generator output required should be less than 1 microvolt. | (*a*) Defective squelch circuit. | (*a*) Check squelch tube V107 and squelch circuit voltages (par. 59*b*(4)). |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| | (*b*) Connect meter M3 in series with 800 ohms to H and J of J203. | (*b*) Meter should indicate 0 ma when rushing noise has disappeared. | | |
| | (*c*) Same as in (*a*) above. Gradually advance test signal input level until tone is heard in headphones. Measure signal input level when tone is heard. | (*c*) Rushing noise should stop. Tone should be heard when test signal input level is about .5 microvolt. | (*c*) Defective squelch circuit. | (*c*) Check squelch tube V107. Check squelch circuit voltage using (M1), a high impedance vacuum tube voltmeter (par. 59*b*). |
| | Measure voltage with meter M1 between H and J of J203. | Meter M1 indicates approximately 4 volts. | | |
| | (*d*) Rotate squelch control to extreme clockwise position. Raise test signal level until tone is heard. Measure test signal level. | (*d*) Tone is heard when test signal level is within a range of 3 to 80 microvolts. | (*d*) Poor receiver sensitivity. | (*d*) Make overall receiver sensitivity check, item (16). Follow up with receiver stage-by-stage gain checks and receiver alinement if sensitivity is poor (pars. 57 and 72). |
| | Measure voltage between H and J (across 800 ohms). | Meter M1 indicates approximately 4 volts. | | |
| (16) Receiver sensitivity. | Reduce the audio output level by means of the VOLUME control until the M4 power output meter indicates 10 mw. | The signal-plus-noise to noise ratio should be at least 20 db. | (*a*) Improper alinement.<br>(*b*) Low gain in RF or IF amplifier stages. | (*a*) Realine receiver circuits (par. 72).<br>(*b*) Make stage gain checks (par. 57). |
| | Remove modulation from test signal and measure audio output level as above. Compute the ratio of the audio output level obtained for a modulated signal to that obtained with the unmodulated test signal. | | | |
| (17) Calibrate oscillator V7. | Connect a high impedance vacuum tube voltmeter (M1) between pin 6 (grid) of V7 and chassis. Turn S202 to the CAL position. | Meter indicates approximately −18 volts dc. | (*a*) Defective Y2_____<br>(*b*) Defective V7.<br>(*c*) Check circuit. | (*a*) Check by substituting another crystal.<br>(*b*) Check tube.<br>(*c*) Check circuit components, particularly contacts of S202. See point-to-point measurements (par. 58). |
| | Adjust trimmer capacitor C48 to obtain a peak reading on the meter. Decrease capacity of trimmer until meter indicates 70 per cent of peak reading obtained above. | | | |

## 55. Transmitter Operational Checks

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (1) Relay circuit | Operate microphone switch. Listen for relay click. | Relay click should be heard. | Defective relay O 101. | Make sidetone check (item (3)). |
| (2) Transmitter power output. | Set S202 in DIAL LIGHT OFF (or ON) position. Make sure that the dummy antenna load (resistor in series with RF meter is connected to the ANT connector). Tune dial to 58-mc position. Operate microphone switch and observe RF meter reading. | Meter reading should be about 100 ma or 500 mw. | (*a*) Misalined transmitter circuits. | (*a*) Check alinement (item (5)). |
| | | | (*b*) Defective transmitter oscillator V3. | (*b*) Check oscillator V3. See transmitter sectionalization chart (par. 56). |
| | | | (*c*) Defective variable 32- to 43.4-mc oscillator V2. | (*c*) Check V2 and oscillator circuit operation, item (1) of transmitter trouble sectionalization chart (par. 56). If correct normal indication is obtained, variable oscillator is operative. |
| | | | (*d*) Defective transmitter mixer, driver, or power amplifier circuits V4, V5, V6. | (*d*) Make voltage measurements at test points E1 through E3. See transmitter trouble sectionalization chart (par. 56). |
| | | | (*e*) Defective relay circuits. | (*e*) Measure the voltages at the screens of V1 (pin 4) and V6 (pin 1), and the filament voltages of V1 and V3 through V6, when the microphone switch is operated. A no-voltage indication at the screen shows that contacts 8 and 9 of relay O 101 are not closed. A no-voltage indication at the tube filaments shows that contacts 2 and 3 of the relay are not closed. Check the relay coil and the relay circuits. Replace the relay if contacts are shown to be defective or the coil is open. |
| (3) Sidetone | Same as above. Set S101 in TANK position. Talk into microphone. Listen with headphones. | Speech should be heard | (*a*) Sidetone circuit not established due to defective relay O 101 contacts. | (*a*) Check relay O 101, and associated circuit components. |
| | | | (*b*) Defective sidetone circuit components or wiring. | (*b*) Check sidetone circuit components. |
| | | | (*c*) Defective audio amplifier V106 or V108. | (*c*) See receiver trouble sectionalization chart (par. 54, item (1)). |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble | Further checks and remarks |
|---|---|---|---|---|
| (4) Sidetone level reduction by S101. | Set S101 in VEH or FIELD position. Repeat operations of item (3). | Volume of sidetone heard, should be considerably reduced. | Defective S101 or R138. | Check the contacts of S101 and circuit components and wiring associated with sidetone circuits (figs. 53 and 54). |
| (5) Overall transmitter tuning. | Same as in item (2), except rotate dial through its entire range, and observe RF meter reading. | The meter reading should not drop more than 10 ma from the reading obtained in item (2). | If the power output of the transmitter varies by more than 10 ma, misalinement of the transmitter RF circuits is indicated. | Realine as described (par. 72). |
| (6) Check of transmitter modulation using test receiver. | Use as FM receiver within the tuning range of the receiver-transmitter under tests as a test device. Operate the microphone push-to-talk button and talk into the microphone. Tune in signal on test receiver. Note the quality of the speech in the test receiver. | Intelligible speech of good quality should be heard. | (*a*) Defective microphone amplifier circuit. | (*a*) Check modulator circuit components. |
| | | | (*b*) Defective microphone amplifier circuit. | (*b*) Check gain of microphone amplifier (par. 56, item (7)). Check V1 and associated circuit components. |

## 56. Transmitter Trouble Sectionalization Chart

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble and further checks |
|---|---|---|---|
| (1) 32- to 43.4-mc oscillator V2 operation. | Measure voltage between terminal 3 of V2 and chassis using meter M1. | | If the voltage is zero, oscillator is not oscillating. Check tube V2. Check circuit components by point-to-point voltage and resistance measurements. If voltage is low, oscillator is weak. Check V2. |
| | (*a*) At 58 mc. | (*a*) −3.5 volts dc at 58 mc. | |
| | (*b*) At 47 mc. | (*b*) −2 volts at 47 mc (approx). | |
| (2) 15-mc transmitter oscillator V3 operation. | Operate the microphone switch and measure the grid voltage at pin 6 of V3 (M1). | −2.5 volts dc (approx) | A zero voltage reading shows that V3 is not oscillating. Check V3; make point-to-point voltage and resistance measurements at the tube socket. Try substituting a crystal known to be good for crystal Y1. |
| (3) Grid drive for transmitter driver V5 (for RT–70/GRC). | Connect meter M1 between test point E1 and pin 7 of V5. For each dial position, operate microphone switch and obtain meter reading. | | Absence of grid drive shows a defect in transmitter mixer V4. Check V4; make point-to-point voltage and resistance measurements at the tube socket; check alinement (pars. 58, 59, and 73). |
| | (*a*) Operate dial to 58-mc position. | (*a*) −.40 volt (approx). | Low grid drive indicates low gain in V4 or misalinement of transmitter mixer stage. |
| | (*b*) Operate dial to 47-mc position. | (*b*) −.40 volt (approx). | |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble and further checks |
|---|---|---|---|
| (4) | | | |
| Grid drive for transmitter driver V5 (for RT-70A/GRC). | Connect meter M1 between test point E1 and pin 7 of V5. For each dial position, operate microphone switch and obtain meter reading. | | Absence of grid drive shows a defect in transmitter mixer V4. Check V4; make point-to-point voltage and resistance measurements at the tube socket; check alinement (pars. 58, 59, and 73). |
| | (*a*) Operate dial to 58-mc position. | (*a*) −.2 volt (approx). | |
| | (*b*) Operate dial to 47-mc position. | (*b*) −.3 volt (approx). | Low grid drive indicates low gain in V4 or misalinement of transmitter mixer stage. |
| (5) | | | |
| Grid drive for transmitter power amplifier V6. | Connect meter M1 between test point E2 and chassis, and proceed as in item (3) above. | −5.5 volts dc (approx) at all frequencies. | Absence of grid drive shows defective stage V5 or V6.<br>Check tubes V5 and V6; make point-to-point measurements of voltage and resistance to locate a defective component in the circuits of V5.<br>Check alinement (par. 73).<br>An excessively high meter reading may indicate that an oscillatory (spurious) condition exists, and that adjustment of neutralization is necessary. Check this by shorting pin 5 on V2 to ground. If voltage at E2 goes to zero, neutralization is approximately correct, otherwise check and adjust neutralization as described in paragraph 74. |
| (6) | | | |
| Plate current of transmitter power amplifier V6. | Connect meter M1 between E3 and pin 11 of J1. | +1.7 volts dc (approx). | A no-voltage indication, when the microphone switch is operated, shows a break in the plate supply circuit, or zero plate current in V6 for other reasons. Turn off power and make continuity measurements to trace the break.<br>A high reading when the microphone switch is closed shows that there is insufficient grid drive on V6, or that antenna trimmer capacitor C41 is not adjusted properly (par. 72).<br>Check tube V6; make point-to-point resistance measurements to discover defective components (par. 58). Make point-to-point voltage measurements (par. 59). |
| (7) | | | |
| Microphone amplifier V1 | Apply a 1,000-cps signal as above. Operate microphone switch. Using meter M2 measure the signal level: | | Check V1. Check circuit components (pars. 58 and 59). |
| | (*a*) Across winding 4–6 of T2. | (*a*) 7.0 volts rms (approx). | |
| | (*b*) Across winding 3–1 of T1. | (*b*) 5.5 volts rms (approx). | |

| Item of check | Test conditions and operation | Normal indication | Possible causes of trouble and further checks |
|---|---|---|---|
| (8) Sidetone level | Connect meter M4 and a 600-ohm load between A of J203 and chassis. Apply 1,000-cycle test signal as in item (6). Operate microphone switch, set VOLUME control to extreme clockwise position, and measure signal level as follows: | | Check sidetone circuit components. Check gain of audio amplifiers V106 and V108 (par. 54, item (1)). Defective S101, R138, R140, or T1. Check these components and associated wiring. |
| | (*a*) Between test point E106 and chassis, using meter M2. Switch S101 set in the VEH or FIELD position. | (*a*) .3 volt rms (approx). | |
| | (*b*) Same as in (*a*). Switch S101 in TANK position. | (*b*) .7 volt rms (approx). | |
| | (*c*) Between A of J203 and chassis, using M4. Switch S101 in VEH or FIELD positi9n. | (*c*) 25 mw (approx). | |
| | (*d*) Same as in (*c*). Switch S101 in TANK position. | (*d*) 105 mw (approx). | |

## 57. Signal Substitution

*a. General.* The purpose of the signal substitution or signal tracing checks described in this paragraph is to localize trouble to a particular stage or part within the circuit group of the receiver-transmitter, which has been shown to be defective by the trouble sectionalization charts (pars. 54–56). The data thus obtained serve also to determine whether alinement for a particular stage or stages is needed.

*b. Test Equipment.* The test equipment required for the signal tracing checks is listed in paragraph 46.

*c. Test Connections.* The dummy antenna load, the cabling, and the power source should be connected as described in paragraph 48 and shown in figure 34. The connections for the test meters and the signal source are to be made as indicated in the stage gain charts included in this paragraph for the particular circuit under test.

*d. Signal Tracing in Receiver.* In general, the procedure of signal tracing described here consists of the following: Connect the meter to the final output circuit of the circuit group under test. Connect the signal generator successively to each of the input circuits preceding that output connection. For each connection of the signal generator, determine the level of the test signal required to obtain the reference reading on the meter. By comparing the values thus obtained with the data given in the stage gain chart, determines whether or not a particular stage provides the required gain. Failure to provide the required gain may be due to either a faulty component or tube within the stage or to improper alinement. The signal generator and meter connections, the required test signal frequency and the required test signal levels, and the reference readings are given stage-by-stage in the stage gain chart (*f* below).

(1) For signal tracing purposes, the receiver is sectionalized into four major groups: audio amplifier stages, 1.4-mc IF stages (including limiter and discriminator stages), 15-mc IF stages (including 13.6-mc oscil-

lator and second mixer), and the RF stages (including variable 32- to 43.4-mc oscillator and first mixer).

(2) For measurements on the audio circuits, the reference reading is the nominal audio power output of the receiver. The reference reading on the limiter meter is the reference level for measurements on all IF and RF circuits. See items (2) and (10) of paragraph 54.

*e. Switch and Control Settings.* The following switch and control settings apply for all measurements on the receiver circuits:

| Switch or control | Setting |
|---|---|
| SQUELCH | OFF. |
| VOLUME | Max clockwise. |
| ANT ADJ-DIAL LIGHT (ON-OFF)-CAL. | DIAL LIGHT ON. |
| Microphone push-to-talk button. | Unoperated. |
| Dial | T9 correspond to test frequency used (see stage-by-stage gain chart). |

*f. Stage Gain Chart.*

(1) *IF circuits.* Perform the following steps in conjunction with the stage-by-stage gain chart.

(*a*) Connect test signal generator G1 between the grid of the indicated stage and chassis.

(*b*) Connect vacuum tube voltmeter M1 between test point E104 and chassis.

(*c*) In all cases, the meter should indicate the reference reading determined as in item (2), paragraph 54.

(2) *RF circuits.* Perform the following steps in conjunction with the stage-by-stage gain chart.

(*a*) Connect test signal generator G1 between the grid of the indicated stage or circuit and chassis.

(*b*) Connect vacuum tube voltmeter M1 between E104 and chassis.

(*c*) In all cases, the meter should indicate the reference reading determined as in item (9), paragraph 54.

(3) *Audio circuits.* Apply an RF signal to the ANT connector at any convenient frequency within the tuning range of the receiver-transmitter. Tune the receiver-transmitter to the signal frequency. Adjust the output of the signal generator to 1 microvolt. Apply 1,000-cps modulation at 15-kc deviation. On the receiver-transmitter, set the VOLUME control to its extreme clockwise position, and the SQUELCH control to its extreme counterclockwise position. Use meter M4 (with its impedance control knob set at 600 ohms) to provide the required 600-ohm load while using M1 to make the voltage measurements between the test points indicated in the chart below and chassis.

*Stage-by-stage gain chart*

| Signal generator at grid of | Approximate input (μv)[a] | Signal generator frequency (mc) | Second limiter grid to ground voltage (volts dc) |
|---|---|---|---|
| V105 | 2,000,000 | 1.4 | −1.4 |
| V104 | 150,000[b] | 1.4 | −1.4 |
| V103 | 9,000 | 1.4 | −1.4 |
| V102 | 2,000 | 1.4 | −1.4 |
| V102 | 3,500 | 15.0 | −1.4 |
| V101 | 400 | 15.0 | −1.4 |
| V11 | 76 | 15.0 | −1.4 |
| V10 | 12 | 15.0 | −1.4 |
| V10 | 150 | 15.0 | −11[b] |
| V9 | 24 | 15.0 | −11 |
| V8 | 15 | 47.0 | −11 |
| V8 | 7 | 58.0 | −11 |
| ANT jack | 1.6 | 47.0 | −11 |
| ANT jack | .8 | 58.0 | −11 |

[a] Microvolts.
[b] Figures thus indicated are adjustment data and are exactly as indicated. All other figures are approximate.

| Point of measurement | Nominal reading (rms volts) | |
|---|---|---|
| | RT-70/GRC | RT-70A/GRC |
| Pin A of J202 | 6.9 (50 mw) | 10 |
| Pin 2 of V108 | 38 | 50 |
| Pin 3 of V108 | 1.9 | 4 |
| Pin 6 of V106 | No test | 9.2 |
| Pin 3 of V106 | 3.2 | No test |
| Pin 4 of V106 | .45 | No test |
| Pin 5 of V106 | No test | .58 |

*g. Analysis.* Compare the signal generator output levels required to give the reference readings with the levels given in the chart. The tabulated data are nominal values. Nonuniformity in tubes, tolerances of components, etc., may be responsible for reading variations between sets as much as 20 per cent. Interpret the test results with this fact in mind. In general, the fault in the circuit group lies between the point at which the abnormal reading is first obtained and the preceding test point. A fault may be indicated by the absence of a reading or by a drastic reduction or increase in a reading.

Large nonuniformity in the readings over the frequency range may be due to improper alinement of the RF circuits. Refer to the schematic diagrams (figs. 53 and 54) to identify the stage to which the trouble has been localized. An excessively high signal generator output level required to provide the reference reading may be due to a defective tube or circuit component or to misalinement of the stage.

*h. Further Trouble Localization Checks.* When trouble has been traced to a given stage or a portion of the stage, do the following:

(1) Turn the power supply off and pull the tube out of its socket.

(2) Test the tube by means of a tube checker. If the tube is defective, replace it with a good one. If a tube checker is not available, substitute a tube known to be good for the suspected one.

(3) Turn on the power and measure the test socket voltages. Refer to paragraph 59 and to figures 37 through 40. Replace any defective components found by this procedure.

(4) Realine the receiver circuits, particularly if the measurements show consistently low gains or after a tuned stage has been extensively repaired.

(5) If alinement fails to improve the condition, investigate the possibility of mechanical defects, such as loose coupling to a capacitor shaft, broken tuning slugs, or defective trimmer capacitors.

(6) Measure the resistances at the tube socket of the defective stage. Refer to paragraph 59 and to figures 37 through 40 for the points of measurement and the required reading. The information given is merely a guide and should suggest other tests, measurements, and procedures for localizing the trouble to defective parts or wiring. Replace any component found to be defective.

## 58. Resistance Measurements (figs. 37–40)

These checks are intended to serve as a guide for locating defective components or wiring in the stage or stages found to be defective by the signal substitution checks of paragraph 57. For these checks disconnect power from the receiver-transmitter. Use meter M3 to make resistance measurements. Replace any component and repair any wiring found to be defective.

*a.* Make the pertinent measurements (figs. 37–40) from the socket terminal to ground. Carefully read the notes on the figure. These notes define the test conditions under which the indicated readings have been obtained. If, for some reason, a departure from the indicated test conditions is desired, the test results must be reinterpreted accordingly. This may be done by reference to the schematic diagrams (figs. 53 and 54) and to the applicable functional diagrams in chapter 2. The required resistance reading are shown below the guide line from the socket terminal. It is necessary to make all measurements shown in figures 37 through 40, but only those indicated at the tube sockets associated with the stage or circuit found to be defective by the signal substitution checks (par. 57) and the other trouble sectionalization checks.

*b.* If the resistance measurements made in accordance with *a* above fail to reveal the cause of the trouble, make detailed measurements on individual components. Refer to the parts list for coil data and to the schematic diagrams (figs. 53 and 54) for circuit details.

## 59. Dc Voltage Measurements

*a. Measurements With 20,000-ohms-per-volt Meter.* Make the pertinent dc voltage measurements indicated in figures 37 and 39 (for RT–70/GRC's) or in figures 38 and 40 (for RT–70A/GRC's). These measurements serve to locate defects which are not readily determined by the resistance measurements (par. 58); that is, defective capacitors, partially shorted transformer and coil windings, etc. For these measurements, make sure that all tubes and crystals are seated firmly in their sockets, and apply power to the unit. All voltage measurements shown in the figures are made to ground. Refer to the schematic diagrams (figs. 53 and 54) to identify the circuit components involved in a particular measurement. Note especially those circuits which are turned off or on by the operation of the microphone push-to-talk button, or by the grounding of terminal K of J203 (par. 36). The required readings are shown above the guide lines from the socket terminals. In some cases, two values of voltages are shown. Those within the parentheses are voltages obtained when the push-to-talk button is operated. Those not in parentheses are obtained when the button is unoperated or when terminal K of J203 or terminal F of J202 is not grounded. The values shown have been obtained with a 20,000-ohms per volt meter. If a meter with another internal resistance is used, the values must be interpreted

accordingly. Repair any part found to be defective as a result of the voltage measurements. The readings given should serve as a guide to other measurements for localizing the trouble to a particular component in the defective circuit. The values given are nominal values and some differences from unit to unit are to be expected.

*b. Measurements with Vacuum Tube Voltmeter.* The data given in the following chart supplement the measurements indicated in Figures 37 through 40. They also supplement (and in some cases repeat) the data given in the trouble sectionalization charts (pars. 54 and 56). Readings are obtained with Electronic Multimeter TS–505/U (M1). The points listed are such that the readings obtained with a low impedance voltmeter lose significance because of the shunting effect of the meter. Except where otherwise stated, all measurements are made between the test point indicated in the chart and chassis.

(1) *Measurements at receiver test points.* For the measurements listed below, use Electronic Multimeter TS–505/U. Turn the SQUELCH control to the extreme counterclockwise (OFF) position. Measure between the indicated test point and chassis. The dc voltage readings are obtained under a no-signal condition of the receiver and will vary approximately 20 per cent and will vary also with setting of antenna trimmer capacitor C41.

| *Point of measurement* | *Circuit or stage* | *Nominal voltage reading (dc volts)* |
|---|---|---|
| E105 | Second limiter grid (V105) | −1.5 |
| E104 | Second limiter grid (V105) | −8.5 |
| E103 | First limiter grid (V104) | +.8 |

(2) *Measurements at receiver oscillator grids.* For the following measurements, use Electronic Multimeter TS–505/U. Turn the SQUELCH control to the extreme counterclockwise (OFF) position. Measure between the points indicated and chassis. The dc voltage readings are obtained under a no-signal condition of the receiver. Set the test switch as indicated. These measurements check whether oscillations are being sustained. Failure to get a reading points to a defective crystal or other component part.

| *Point of measurement* | *Circuit or stage* | *Test switch S202 setting* | *Nominal reading (dc volts)* |
|---|---|---|---|
| V7, pin 6 | Calibrate oscillator | ANT ADJ | −18 |
| V7, pin 6 | Calibrate oscillator | CAL | −18 |
| V102, pin 4 | Second receiver mixer oscillator | | −.8 to −.2 |
| V106, pin 6 (RT–70/GRC) | Beat oscillator | CAL | −2.5 |
| V2, pin 5 | 32-43.4-mc oscillator | | −2.0 to −3.5 |
| V106, pin 3 (RT–70A/GRC) | Beat oscillator | CAL | .6 |

(3) *Measurement of discriminator output voltages.* The following measurements are a summary of the measurements made in paragraph 54, item (8).

(*a*) Connect Electronic Multimeter TS–505/U between test point E106 and chassis.

(*b*) Connect 1.4-mc generator G1 through a .003-μf capacitor between pin 6 of V104 and chassis.

(*c*) Adjust the generator to each of the frequencies indicated below, and to an output level of 150,000 microvolts (.15 volt) rms for each frequency.

(*d*) The following readings should be obtained for a properly balanced discriminator.

| *Frequency (kc)* | *Normal reading (dc volts)* |
|---|---|
| 1470 | +11 (peak). |
| 1330 | −11 (peak). |
| 1430 | +6 (for RT–70/GRC; +5). |
| 1370 | −6 (for RT–70/GRC; −5). |

(4) *Measurements of squelch circuit voltages.* The following measurements supplement the checks of paragraph 54 item (15). Use Electronic Multimeter TS–505/U to make the indicated voltage measurements. Turn the SQUELCH control to the extreme clockwise position. Measurements are made between indicated points and chassis.

| *Point of measurement* | *Nominal reading (dc volts)* |
|---|---|
| Pin 3 of V107 | −70 |
| Pin 3 of V108 | −60 |

(5) *Measurement of transmitter oscillator grid voltages.* Use meter M1 to make the following measurements:

| *Point of measurement* | *Test conditions* | *Nominal reading (dc volts)* |
|---|---|---|
| Pin 5 of V2 | Dial set to 58 mc | −3.5 |
| Pin 5 of V2 | Dial set to 47 mc | −2.0 |
| Pin 6 of V3 | Operate microphone switch | −2.5 |

(6) *Measurements at transmitter test points.* Use Electronic Multimeter TS–505/U to make the following measurements. For these measurements, the dial may be set in any convenient midscale position. Operate the microphone to place transmitter on.

| *Point of measurement* | *Nominal reading (dc volts)* |
|---|---|
| Between E1 and pin 7 of V5 | −.4 |
| Between E2 and chassis | −5.5 |
| Between E3 and pin 11 of J1 | +1.7 |

## 60. Check of Interunit Strapping Connections

The continuity checks outlined below should be made to determine whether the strapping connections between panel-mounted multiconnectors in the receiver-transmitter are made properly. The strapping connections serve to interconnect the receiver-transmitter with other units of the system in which it is used. Use an ohmmeter to check for continuity between the points listed below. In each case, a reading of zero ohms should be obtained. Otherwise, the wire connecting the two terminals in question is broken or the connector pin is defective. Repair as necessary.

From term. A of J202 to term. A of J203.
From term. J of J202 to term. E of J203.
From term. B, E, and H of J302 to chassis.
From term. C of J202 to term. C of J203.
From term. F of J202 to term. K of J203.
From term. D of J203 to chassis.

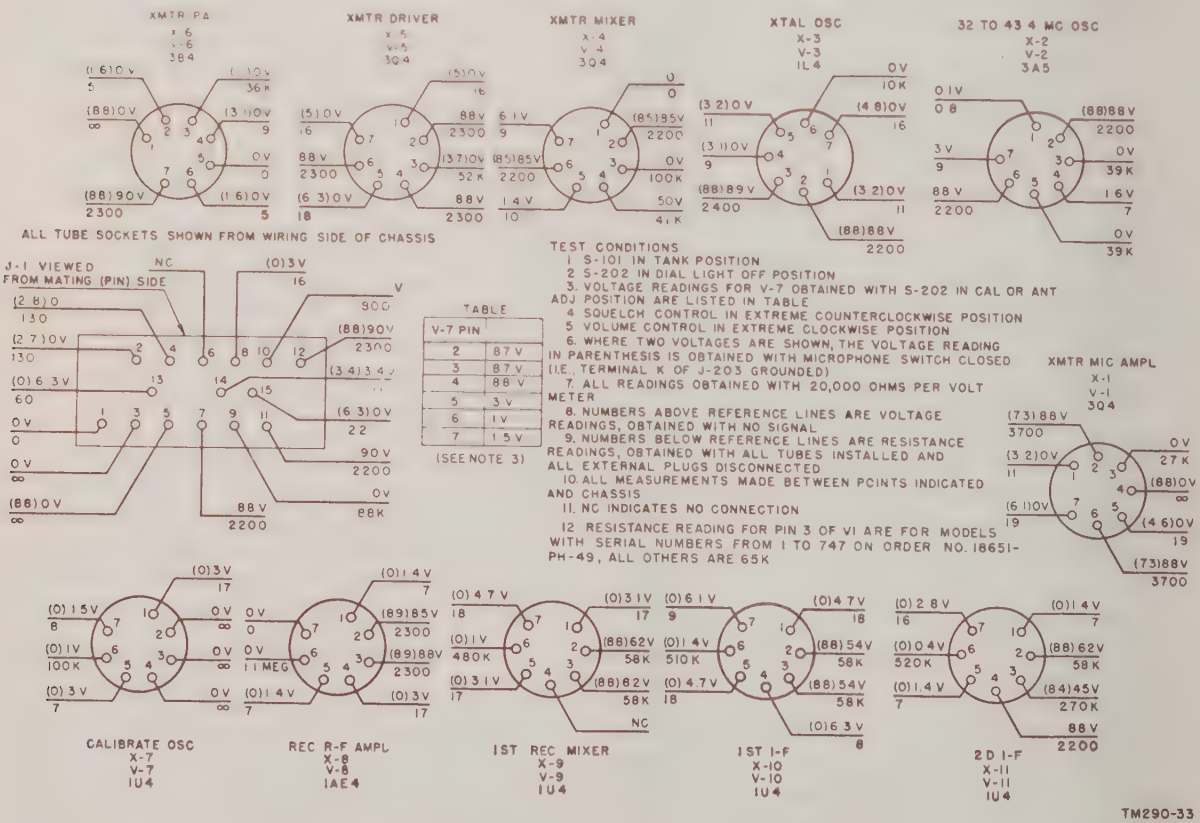



*Figure 37. Resistance and voltage data, RF chassis (RT–70/GRC).*

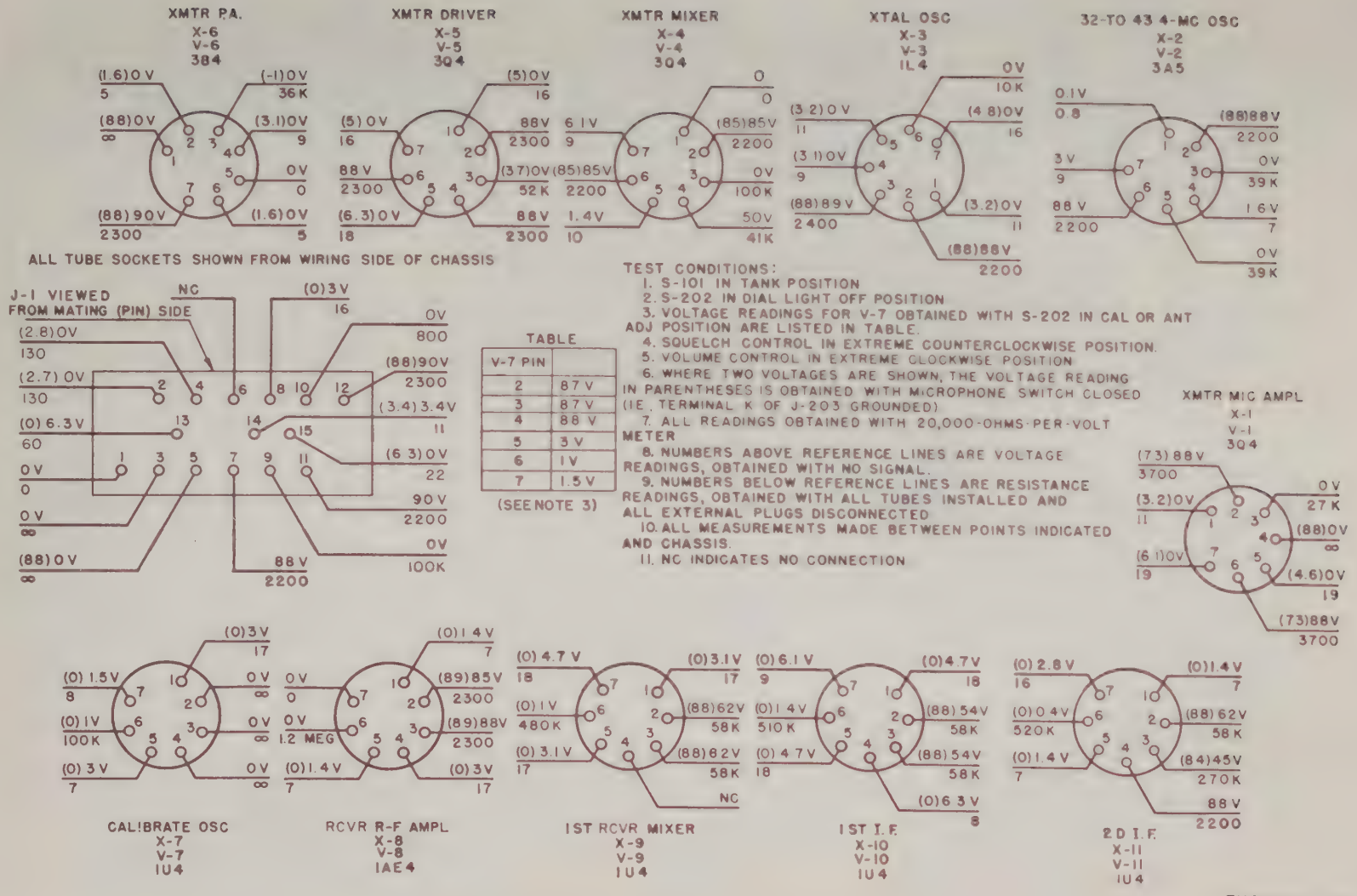



*Figure 38. Resistance and voltage data, RF chassis (RT-70A/GRC).*

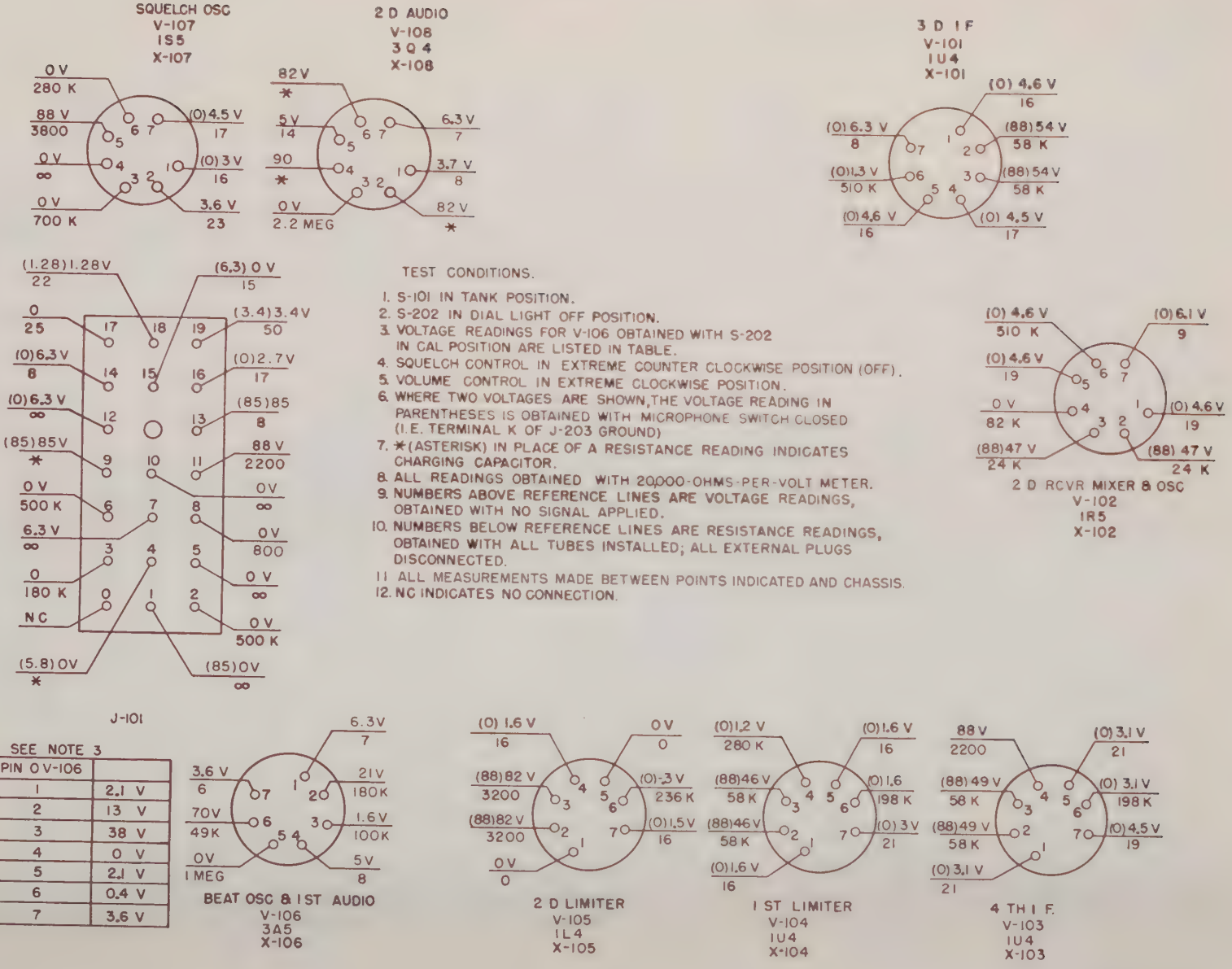



*Figure 89. Resistance and voltage data, IF chassis (RT-70/GRC).*

TM290-C2-34

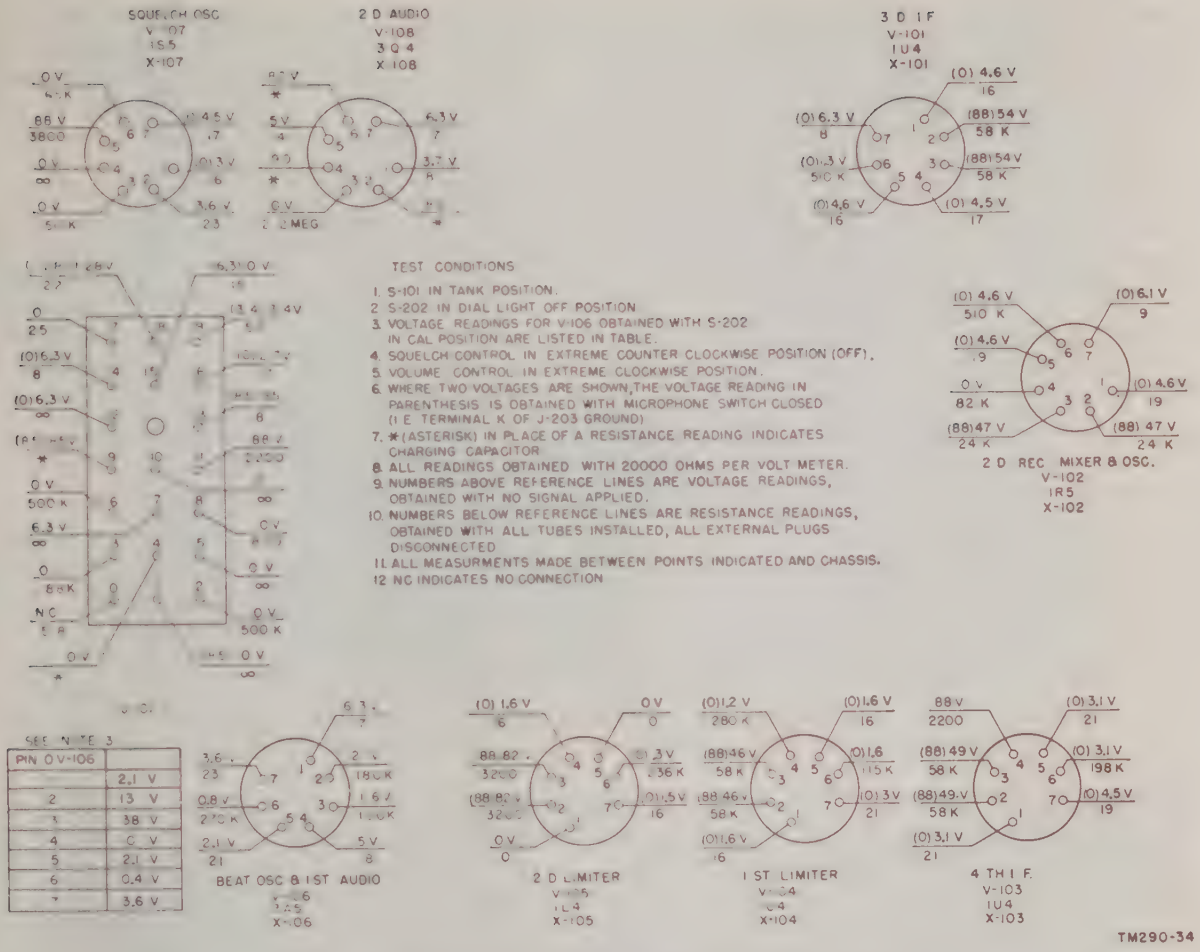

SQUELCH OSC
V-107
1S5
X-107
2D AUDIO
V-108
3Q4
X-108
3D IF
V-101
1U4
X-101
TEST CONDITIONS
1. S-101 IN TANK POSITION.
2. S-202 IN DIAL LIGHT OFF POSITION
3. VOLTAGE READINGS FOR V-106 OBTAINED WITH S-202 IN CAL POSITION ARE LISTED IN TABLE.
4. SQUELCH CONTROL IN EXTREME COUNTER CLOCKWISE POSITION (OFF).
5. VOLUME CONTROL IN EXTREME CLOCKWISE POSITION.
6. WHERE TWO VOLTAGES ARE SHOWN, THE VOLTAGE READING IN PARENTHESIS IS OBTAINED WITH MICROPHONE SWITCH CLOSED (I.E. TERMINAL K OF J-203 GROUND)
7. * (ASTERISK) IN PLACE OF A RESISTANCE READING INDICATES CHARGING CAPACITOR
8. ALL READINGS OBTAINED WITH 20000 OHMS PER VOLT METER.
9. NUMBERS ABOVE REFERENCE LINES ARE VOLTAGE READINGS, OBTAINED WITH NO SIGNAL APPLIED.
10. NUMBERS BELOW REFERENCE LINES ARE RESISTANCE READINGS, OBTAINED WITH ALL TUBES INSTALLED, ALL EXTERNAL PLUGS DISCONNECTED
11. ALL MEASURMENTS MADE BETWEEN POINTS INDICATED AND CHASSIS.
12. NC INDICATES NO CONNECTION
2D REC MIXER & OSC.
V-102
1R5
X-102
SEE NOTE 3
PIN 0 V-106
2.1 V
13 V
38 V
0 V
2.1 V
0.4 V
3.6 V
BEAT OSC & 1ST AUDIO
2D LIMITER
1ST LIMITER
4TH I.F.
V-103
1U4
X-103
TM290-34

*Figure 40. Resistance and voltage data, IF chassis (RT–70A/GRC).*

## Section II. REPAIRS

### 61. Repair Procedures

This section describes the procedure for disassembling the major subassemblies of Receiver-Transmitter RT–70(*)/GRC, removal and replacement of components, and subassemblies found to be defective by the trouble-shooting procedures of the preceding section and by the inspection procedure described in paragraph 63.

### 62. Disassembly for Inspection, Cleaning, and Repair

(figs. 41–47)

*a. Outer Case.* To remove the outer case, loosen the four Dzus fasteners around the edges of the front panel. Slide the panel-and-chassis assembly out of the case. Do not damage any wiring or components while removing the cover or while the panel-and-chassis assembly is being handled without the cover. The component side of the RF and IF chassis can be inspected and cleaned without taking the assembly apart. However, to gain access to the RF coils, to components mounted on the back of the panel, or to components mounted between the two chassis, it is necessary to remove either the IF chassis or the RF chassis. It is preferable to remove the IF chassis first, in accordance with the procedure outlined in *b* and *c* below. Under certain conditions, especially if parts are to be replaced on the panel or on the RF chassis, it is desirable to remove the RF chassis next. A disassembled view of the unit is shown in figure 41.

***Caution:*** Be very careful during the disassembly

procedure; the assembly is somewhat intricate and the parts are delicate. Careless handling may cause damage to parts. Side pressure on the coupling between the dial-drive assembly and the shaft of the gang capacitor may cause damage to the gang capacitor or the coupling.

*b. Removal of IF Chassis.* Component and wiring side views of the IF chassis are shown in figures 43 and 44, respectively. To disengage the IF chassis, proceed as follows:

(1) Place the unit on a solid support in its correct operating position.

(2) Withdraw multiconnector P202 from J101 on the IF chassis. These connectors are located on the chassis near the panel.

(3) Disengage pin connector P1 joining the plate of V11 on the RF chassis to pin 2 of T101 on the IF chassis. This lead is located on the top rear of the panel-and-chassis assembly.

(4) To remove the backplate, loosen the two large retaining bolts (fig. 7) which hold the backplate to the IF chassis. These bolts are located in the rear corners of the chassis.

(5) In the manner similar to that described above, remove the two retaining bolts which hold the backplate to the RF chassis (fig. 6). These bolts are located in the rear corner of the RF chassis.

(6) Remove the backplate.

(7) Remove the two captive bracing screws located on the IF chassis (fig. 7) just in front of relay O 101. These screws engage threaded holes on the RF coil compartment (mounted on the wiring side of the RF chassis) and assure a secure and rigid panel-and-chassis assembly.

(8) Remove the two chassis mounting screws (fig. 5) which hold the IF chassis to the projections from the rear of the panel.

(9) Very carefully lift the IF chassis away from the rest of the assembly. Be careful not to bend the chassis out of shape or to damage any of the components mounted on either the RF or IF chassis.

*Note.* For most purposes, it will not be necessary to disassemble the unit further. Disengage the RF chassis from the panel only as need arises.

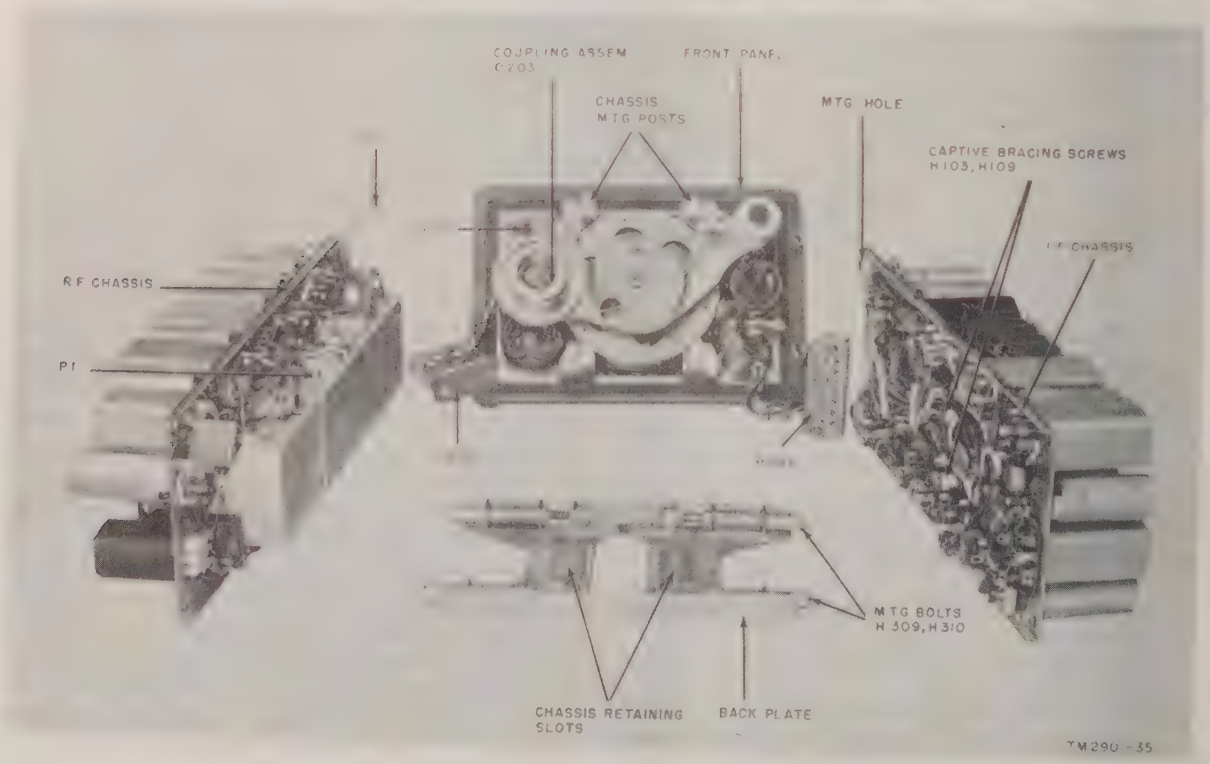



*Figure 41. Receiver-Transmitter RT–70(*)/GRC, disassembled view.*

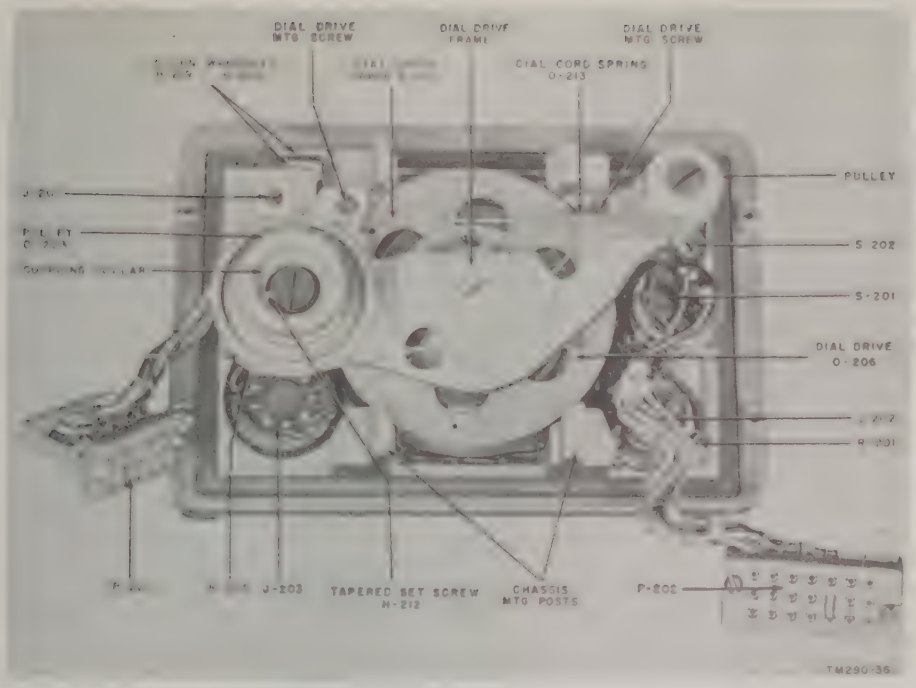



*Figure 42. Receiver-Transmitter RT-70(*)/GRC, rear view of panel.*

*c. Removal of RF Chassis.* Component and wiring side views of the RF chassis are shown in figures 45, 46, and 47. To disengage:

(1) Withdraw multiconnector P201 from J1. This connector is located on the RF chassis near the panel (fig. 6).

(2) Disengage pin connector P2 (fig. 6) from the pin on ANT connector J201 at the rear of the panel.

(3) Use a No. 564 allen wrench (located in a bracket on the back of the front panel) (fig. 5) to release the No. 8 set screw associated with the *green* dot on the coupling between the large pulley on the dial-drive mechanism and the gang capacitor. The set screw becomes accessible by turning the tuning dial to the 47 mc position and is the set screw which is flush with the rim of the coupling (fig. 6).

*Note.* Two recessed set screws associated with the *red* dots are not to be touched. These set screws hold the coupling to the dial-drive mechanism.

(4) Remove the two chassis mounting machine screws (fig. 5) which hold the projections from the rear of the panel to the RF chassis.

(5) Carefully lift the RF chassis from the panel. Be careful not to cause damage to the couplings, gang capacitor shaft, or to components.

## 63. General Inspection of Chassis

If the unit has been disassembled as described in paragraph 62, it is possible to inspect all parts and wiring. Inspect the unit thoroughly for any abnormal conditions. If any are found, the cause of such conditions should be determined and the defects remedied. Repair instructions for defective components, located by the inspection described below or by the troubleshooting procedure described in the preceding paragraphs, are given in paragraphs 65 and 66.

*a.* Inspect all parts for rust, corrosion, breakage, or other damage.

*b.* Inspect wiring for loose connections, frayed or burned insulation, and mounting hardware for mechanical defects. Examine the chassis for dirt and corrosion.

*c.* Examine lugs on capacitors, transformers, chokes, switches, connectors, and tube sockets for loose connections or breaks. Examine all switches, nuts, bolts, and other mounting hardware on the

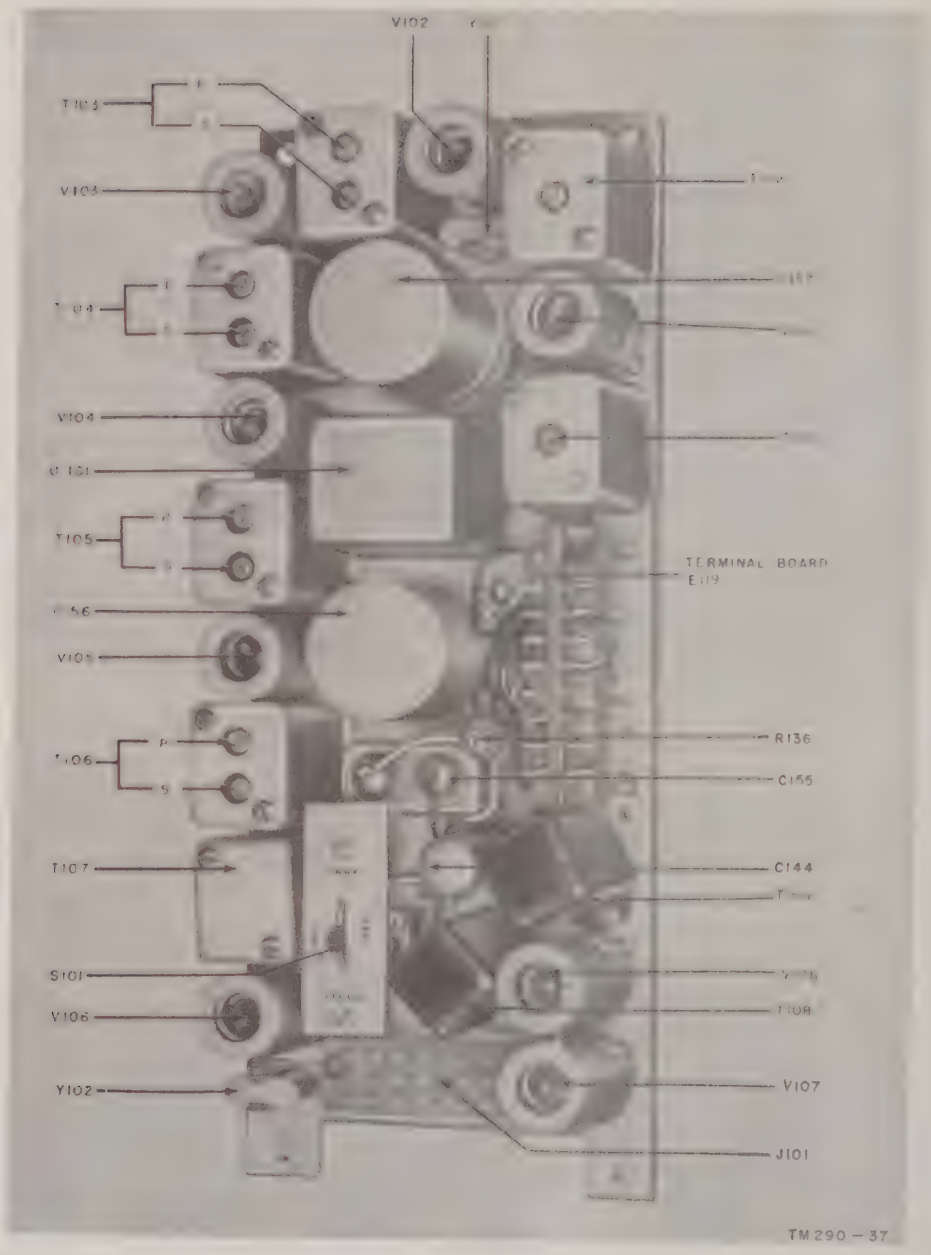



*Figure 43. Receiver-Transmitter RT–70(*)/GRC, component side of IF chassis.*

chassis to make sure that they are not loose. Loose mounting hardware may cause intermittent noises in the set which are very difficult to locate except by visual inspection.

*d.* Inspect all sockets for broken, excessively spread, or corroded and dirty contacts. Check mounting hardware and mounting rivets to determine whether sockets are held firmly to the chassis. See that tube shields are held firmly in their bases when installed and that springs are seated properly within the tube shield.

*e.* Examine connectors for loose mounting hardware, dirty or corroded contacts, or improper contact tension. Where applicable, adjust and try the action of the connector after adjustment. Make sure that solder connections and wiring to the con-

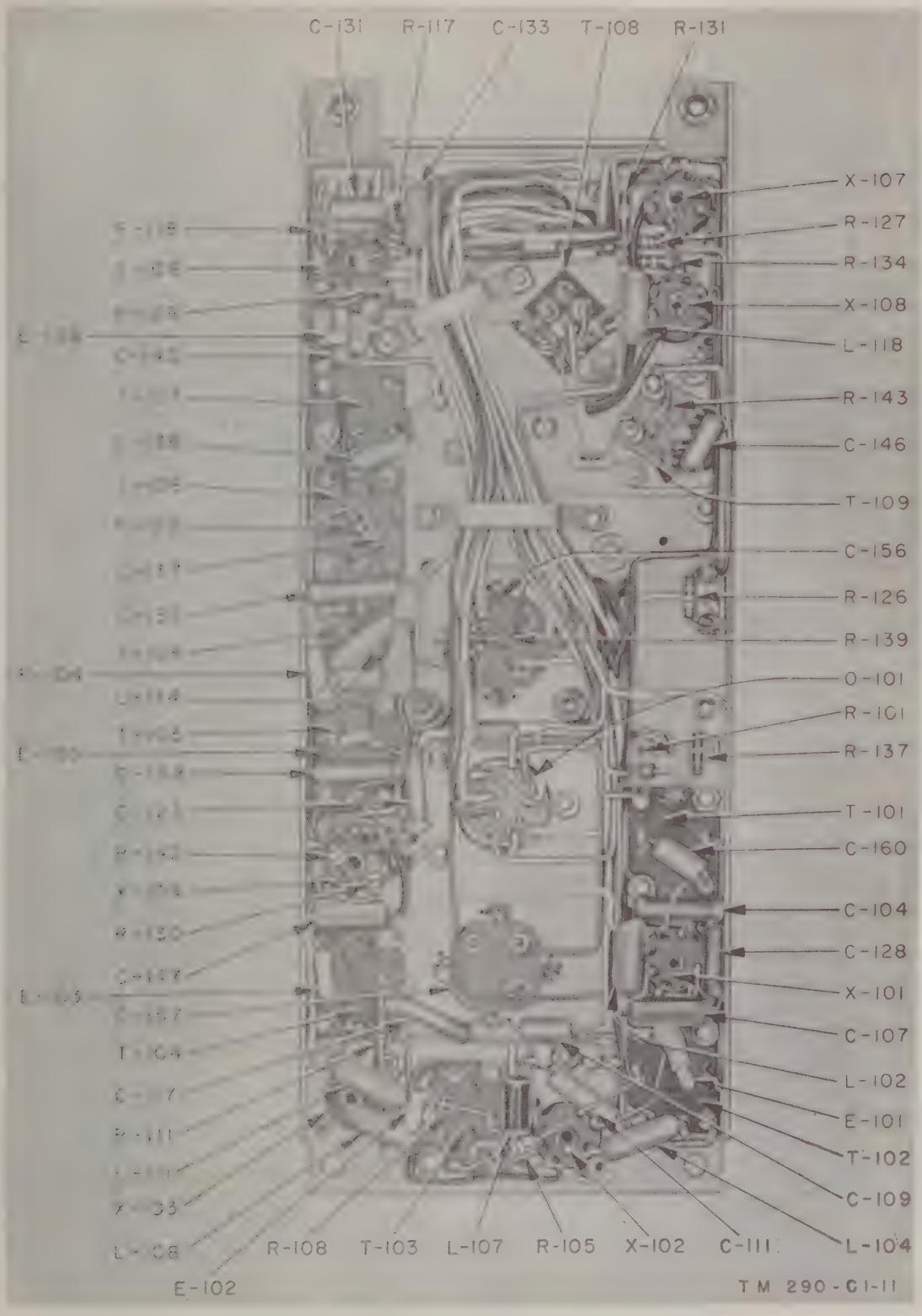



*Figure 44. Receiver-Transmitter RT-70(*)/GRC, wiring side of IF chassis.*

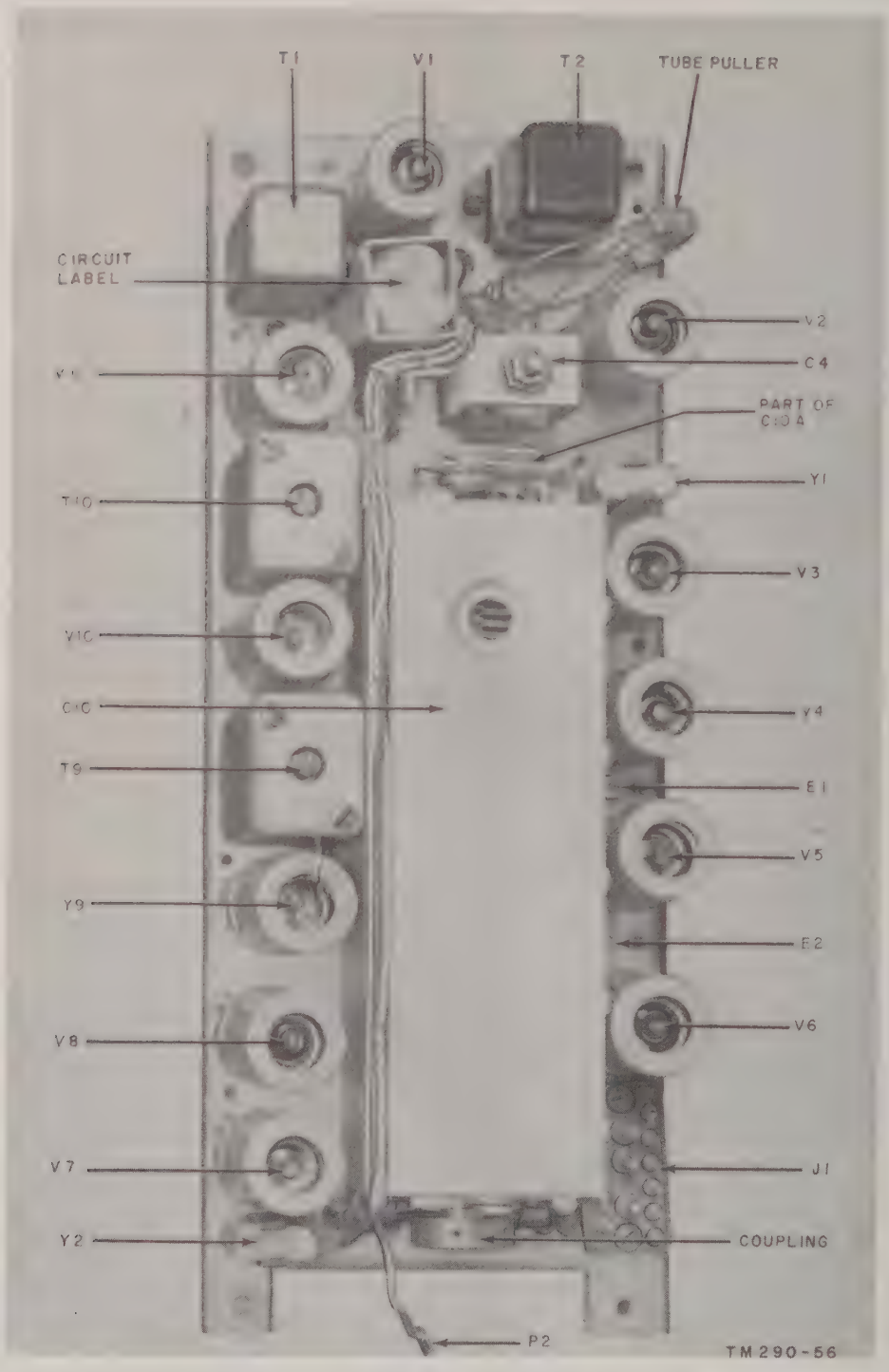



*Figure 45. Receiver-Transmitter RT–70(*)/GRC, component side of RF chassis.*

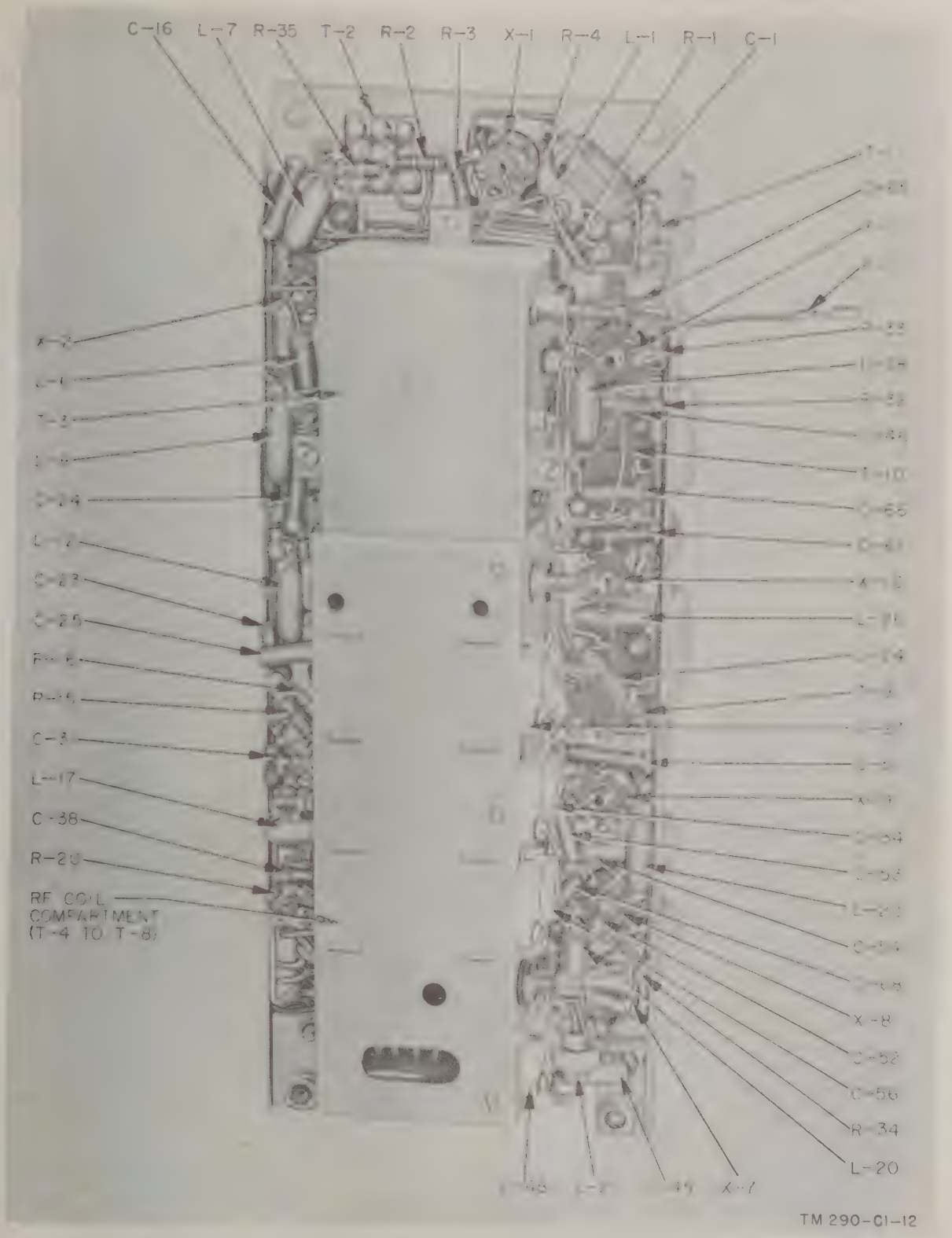



*Figure 46. Receiver-Transmitter RT-70(*)/GRC, wiring side of RF chassis.*

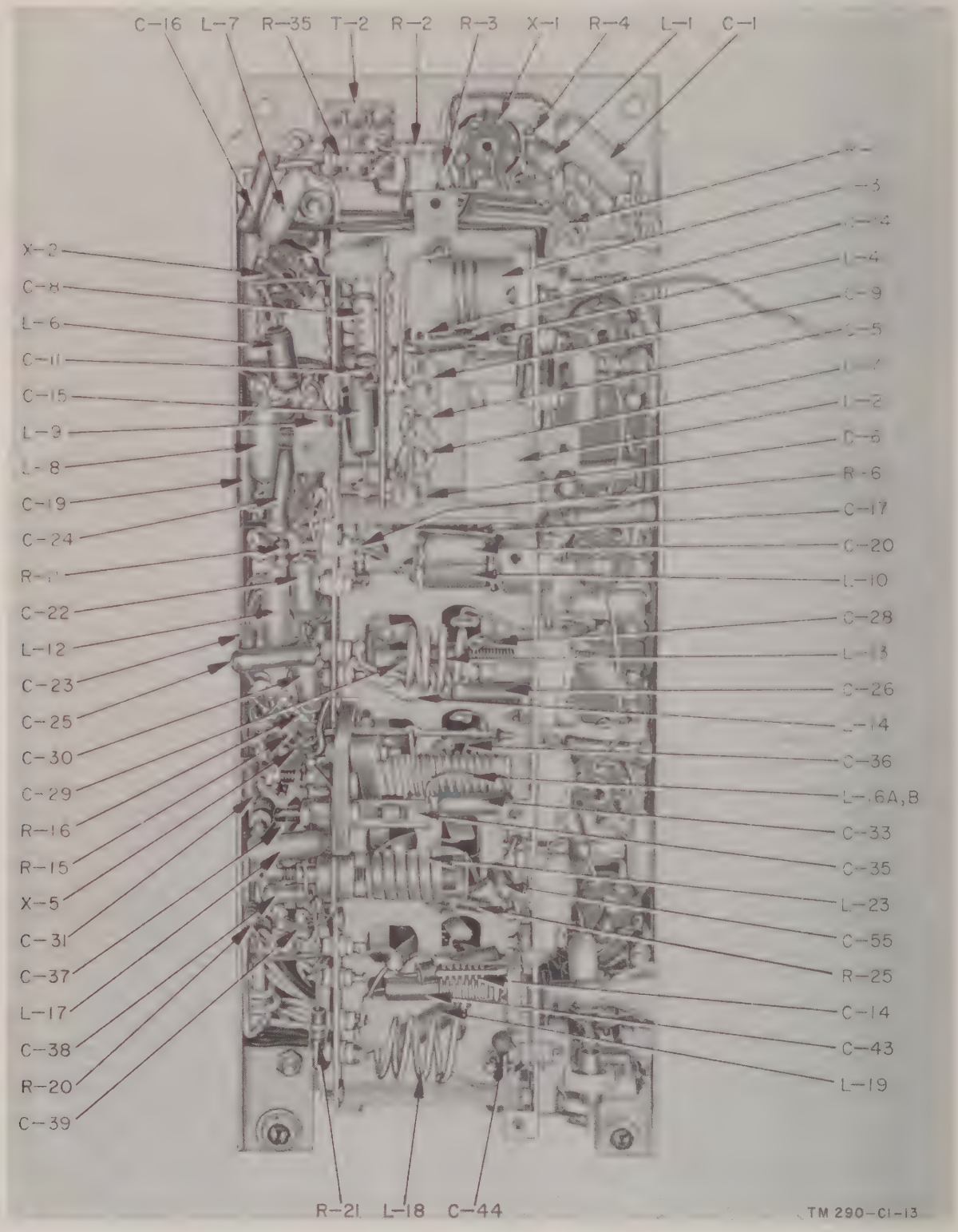



*Figure 47. Receiver-Transmitter RT-70(*)/GRC, wiring side of RF chassis; with coil compartment covers removed.*

nectors are not broken, frayed, or loose. See that handles are screwed firmly since the loose handle may short-circuit connector lugs.

*f.* Examine fixed capacitors for signs of discoloration, leaks, bulging, dirt, loose mounting hardware, or loose connections. Melted or oozing wax or other dielectric is a sign of damage to the part. Such capacitors should be tested electrically and replaced with good ones if found to be defective.

*g.* Examine resistors for blistering, discoloration, or other signs of overheating. Inspect connecting leads for corrosion, dirt, looseness, and broken or trailing strands of wire. Discoloration of a resistor usually indicates that the component has been operated under overload. Overheating is a sign of a defect in another part.

*h.* Inspect the variable capacitor on the RF chassis for accumulation of dirt, dust, or lint. Examine the plates for signs of damage, misalinement, or binding that would cause them to touch other plates during turning. Check for loose terminals, mounting hardware, and connections. Make sure that the two slotted plates on the rear shaft of the capacitor are mounted firmly, and that in the extreme counterclockwise position of the capacitor shaft the last segment of the plates lines up with the index mounted on projections from the capacitor. This index represents the fixed plate of the notched oscillator tracking plates (fig. 45).

*Note.* Unless trouble with the capacitor is definitely suspected, it is not advisable to remove the capacitor cover. When doing so, be careful not to damage or bend the capacitor plates.

*i.* Remove the covers of the tuning assemblies mounted on the wiring side of the RF chassis (fig. 46) by removing the retaining screws at the top and side of the cans. Examine the components inside the cans (fig. 47) to make sure that they are not damaged, that the wiring between the components and to the terminal lugs (on the side walls of the assembly) is not broken, frayed, or loose. Check the tuning slugs (on the side walls of the assembly) to make sure that they are not loose or broken and that the spring clips are installed. These spring clips insure that the tuning slugs remain firm after adjustment.

***Caution:*** Do not turn adjusting slugs since they will throw the set out of alignment.

*j.* Examine spring clips and crystal sockets to make sure that the crystal is held firmly to the socket.

*k.* Operate switches on the panel (fig. 1) and on the IF chassis (fig. 43) to each one of their operating positions to determine that they work easily with no searching for contacts. Where switch contacts are accessible, examine for evidences of corrosion, improper contact, or dirt. Proper switch contact may best be determined by continuity measures.

*l.* See that all metal shield cans of tuning assemblies on the RF and IF chassis are firmly mounted to the assembly posts. Loose shield cans may contribute to noise and poor operation of the equipment. Mounting hardware and rivets associated with containers should be tightened, if necessary.

## 64. Cleaning

*a.* Dirt or corrosion will interfere with electrical continuity and mechanical efficiency of the parts and of the unit by causing circuits to be shorted or insulated, or by causing switches to be jammed. For these reasons, it is important to clean all parts of the chassis and panel carefully and thoroughly.

*b.* No set method can be given for removal of dirt because of the many ways and places it collects. Cleaning should be done with a lint-free cloth, fine sandpaper (No. 000), crocus cloth, or a soft brush. Dust and grease can usually be removed with a cloth or brush moistened with cleaning compound (Federal stock No. 7930–395–9542). Never use gasoline for cleaning. Be very careful when cleaning delicate parts which are difficult to reach to avoid damage to wiring or parts. Where it is necessary to remove portions of moisture-fungus-proofing to clean a part properly, refinishing is essential.

*c.* When handling the chassis during cleaning, or at any other time, be careful not to break wiring or small parts. Lift the chassis by the metal sides and keep fingers off the sides where small wires and components are located.

*d.* Clean cases of fixed capacitors and other components to remove all dirt and corrosion. In most cases, a dry cloth will do the job. If deposits of dirt are hard to remove, moisten the cloth with cleaning compound. Dry carefully.

*e.* Clean small components, such as resistors, with a small brush. Clean dirty or corroded socket, connector, and switch contacts with crocus cloth to remove corrosion; then clean with cleaning compound. Handle wafer switches with care. The wafers are fragile.

*f.* Before cleaning moving parts, such as variable capacitors, or parts which accumulate dirt easily and are difficult to reach, clean the chassis in general. Be careful not to break or damage wiring or components during the process of cleaning the chassis.

*g.* Remove all dust and lint between variable capacitor plates, in the capacitor container, and at the point where the plates are held to the capacitor shaft. Be careful not to bend, distort, or otherwise damage the plates. Clean mounting brushings, mounting hardware, trimmer capacitors, and couplings associated with the variable air capacitor.

## 65. Replacement of Parts

When replacing parts in Receiver-Transmitter RT-70(*)/GRC, observe the precautions given below:

*a. Tagging Leads.* Tag all leads to assure that correct rewiring will be made when a part is replaced. Before unsoldering leads from transformer, tube sockets, panel connectors, or other parts, tie together the leads that are attached to each of these parts. With a small tag or short piece of adhesive tape, identify all wires in accordance with their numbered conditions. Identify every lead that is to be removed. Refer to the schematic diagrams, figures 53 and 54.

*b. Parts and Substitution.* When damaged parts must be replaced, identical parts should be used. If identical parts are not available and the damaged component is beyond repair a substitution must be made. The part substituted must have identical electrical properties and must be of equal or higher voltage and current rating.

*c. Location.* Relocation of substituted parts may develop certain difficulties such as regeneration hum, noise, or cross talk and is not recommended.

*d. Mounting.* Mount the new or replaced parts in the same mounting position as that formerly occupied by the damaged part. Fasten all mountings securely.

## 66. Special Repair Procedure

Most of the parts in the receiver-transmitter are readily accessible and can be replaced without special procedure instructions. Most of the small components such as resistors, small capacitors, and small choke coils, are wired point-to-point directly to the lugs of sockets and terminals of tuning units. In replacing these parts, be careful not to damage adjacent components. Special procedures for repairing or replacing sockets, connectors, and some of the more complicated subassemblies are given in *a* through *m* below. Since the unit is very compact and many of the components are sandwiched between the IF and RF chassis, it will be necessary to disassemble the unit as described in paragraph 62 before the mechanical repair and replacement procedures described below can be followed. In many cases, disassembly of the unit before the part is replaced will prevent damage to other parts. It is a matter of judgment to decide when it is necessary to disassemble the unit and when it is possible to do the replacement without disassembly.

*a. Sockets.* All tube sockets are attached to the chassis with rivets. To replace a socket, proceed as follows:

(1) Disassemble the particular chassis from the rest of the unit to prevent possible damage by the tools used in removing the part.
(2) Remove the tube shield and the tube plugged into the socket.
(3) Unsolder the wires connected to the socket.
(4) Drill out the two rivets fastening the socket to the chassis.
(5) Substitute a new socket and fasten it with machine screws, lockwashers, and nuts, or with rivets. Make sure that the socket is keyed the same way as the socket which was removed.
(6) Resolder the wires and components to the socket.
(7) Clean the chassis thoroughly to remove solder drops or metal chips.
(8) Check the new connections with those shown on the schematic diagrams (figs. 53 and 54).

*b. Standoff Insulators.* The standoff insulators have rivet type bars. To remove, unsolder the leads attached to the insulator and drill out the rivet. Substitute a new insulator and spread the unit type base with a nail punch or suitable tool.

*c. Panel Connectors.* Use a spanner wrench or long-nosed pliers, and proceed as follows:

(1) Disengage the panel from the rest of the assembly to gain access to the rear of the panel (fig. 42). Insert the teeth of the spanner wrench into the notches in the nut of connector on the front panel. Turn the spanner wrench in the counterclockwise direction until the nut is removed. Remove the lockwasher.

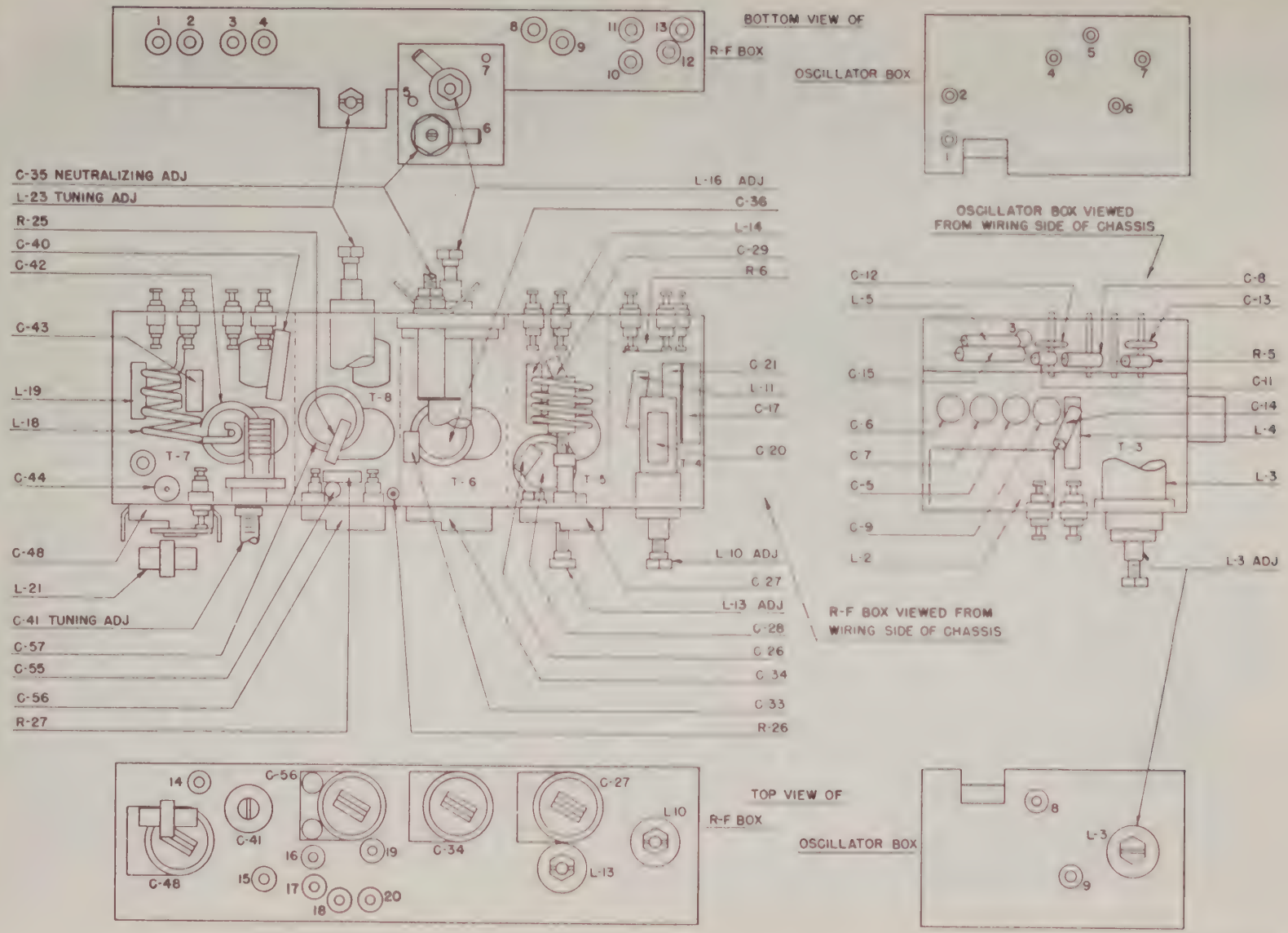



*Figure 48. RF coil compartment, componet location diagram.*

(2) Unsolder all wires.
(3) Remove the connector from the rear of the panel.
(4) In selecting a new connector, make sure that the new part has a rubber gasket.
(5) Resolder all wires to the new connector.
(6) Clean thoroughly to remove solder drops.
(7) Recheck the new connections with those shown in the schematic diagrams (figs. 53 and 54).
(8) Reinsert the connector from the rear of the panel.
(9) Reinsert the lockwasher and the nut with the spanner wrench.
(10) Screw the nut on the connector. Check the assembly for tightness.
(11) Reassemble the panel to the rest of the unit.

*d. Replacement of RF Coils.* The RF coils of both the transmitter and the receiver are located in compartments of an assembly mounted on the wiring side of the RF chassis (fig. 47). The location of parts, terminals, and tuning controls in the RF coil compartment is detailed in figure 48.

(1) Disassemble the RF chassis from the rest of the panel and chassis assembly as described in paragraph 62. Place the RF chassis with the wiring side up.
(2) Remove the six (three on top and three on the side) machine screws which hold the cover of the coil compartment in place. The partitions separating the RF coils from each other are part of the cover.
(3) To replace any of the RF coils, proceed as follows:
  (*a*) Unsolder the leads connected to the coil. Be careful not to damage the delicate coil windings.
  (*b*) Unscrew the large nut located on the outer side of the compartment frame. Be careful not to lose the small spring clip which grips the tuning slug to the nut. This clip insures that the tuning slug holds its adjustment.
  (*c*) Remove the coil.
  (*d*) Insert the replacement coil.
  (*e*) Resolder all connections and restore the nut and tuning slug assembly. Make sure that the spring clip is in place, otherwise the tuning slug will get loose and come out of adjustment.
  (*f*) Carefully clean away all solder drops.
(4) Replace the cover and mounting screws.

*e. Replacement of Variable Gang Capacitor C10.* Variable gang capacitor C10 is mounted on the component side of the RF chassis. To replace the capacitor, remove the RF chassis from the rest of the assembly and proceed as follows:

(1) Turn the unit, wiring side up, and remove the RF coil compartment cover, as described above.
(2) Unsolder all the leads from the capacitor lugs projecting through holes in the chassis plate into the RF coil compartment.
(3) Remove the two screws at the front end of the capacitor and the one screw at the rear of the capacitor, which hold C10 to the chassis.
(4) Lift the capacitor off the chassis.

***Caution:*** Do not remove the coupling or the slotted plates from the capacitor shaft. If these plates are broken, replace the capacitor.

  (*a*) Place the repaired or new capacitor on the RF chassis so that the holes in the mounting brackets at the front and at the rear of the capacitor line up with the corresponding holes on the chassis plate.
  (*b*) Insert and tighten the three mounting screws.
  (*c*) In placing the capacitor on the chassis, make sure that the capacitor lugs clear the holes on the chassis plate.
  (*d*) Reconnect all solder connections to the capacitor lugs; be sure that the proper connections are made.

*f. Replacement of Components in Shield Cans.* The tuning units on the RF and IF chassis are mounted by means of two studs, which are part of the tuning unit assembly, and two nuts. To replace the unit as a whole, unsolder the leads and remove the two nuts on the wiring side of the chassis. To gain access to components within the can, remove the two screws at the top of the can that hold the cover to the assembly. Lift off the cover.

*g. Replacement of Dial-drive Cable.* To replace the dial-drive cable, it is necessary to disengage the panel by removing the IF and RF chassis as described in paragraph 62. The cable replacement procedure is illustrated in figure 49. The steps indicated in figure 49 are keyed to the procedure outlined below. The procedure assumes that a cable, fitted with terminal lugs at each end, is available. (Since a special crimping tool is re-

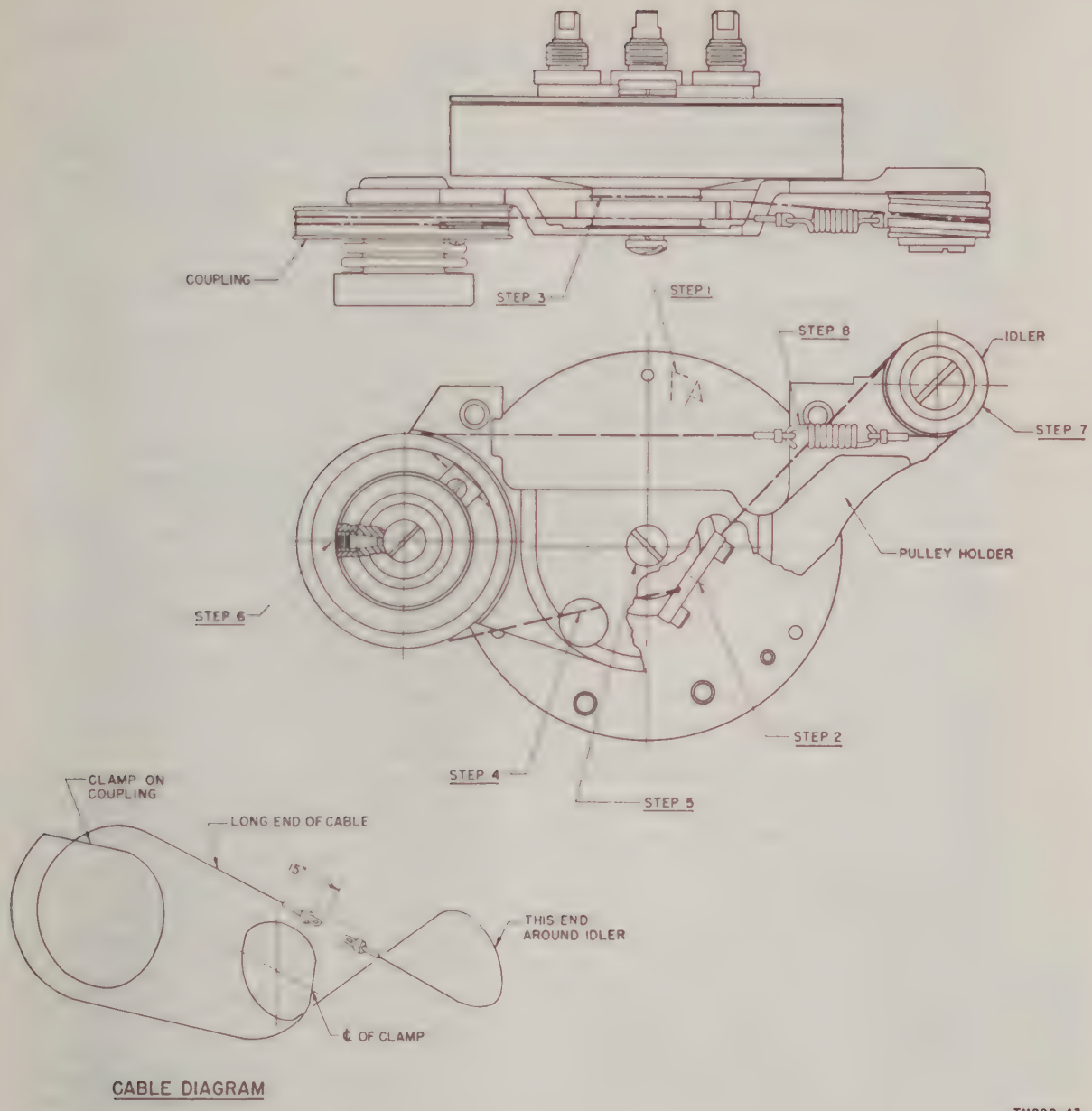



*Figure 49. Replacement of dial-drive cable.*

quired to attach the lugs to the cable do not attempt preparation of the cable unless such a tool is available.) First remove the pulley holder from the dial-drive assembly. To do this, remove the large screw ((5) below) which mounts the pulley holder to the drum assembly. Remove the two screws which mount the holder to the panel.

(1) Rotate the dial (with knob on front panel) to its lowest frequency setting until it comes to rest at the top.

(2) Measure and mark off 15 inches of cable from the end of one terminal lug. (The length of cable from that lug to the 15-inch mark is identified below as the long cable section, and the terminal lug as the long end of the cable. The other terminal lug is identified as the short end of the cable.) Fasten the cable assembly to the drum so that the long end of the cable faces the large pulley and the 15-inch mark on

the cable coincides with the center line (C) of the clamp.

(3) Wrap the short end of the cable (end facing small pulley) around the drum assembly, as shown in the cable diagram of figure 49.

(4) Insert the long end of the cable through the hole in the pulley holder.

(5) Reattach the pulley holder to the drum assembly.

(6) Rotate the coupling (large pulley) until the screw hole marked with green paint is pointed outward and is on the horizontal centerline of the dial drive. Now clamp the cable to the coupling and wrap around as shown in the cabling diagram.

(7) Set the idler pulley (small) in the approximate position shown in figure 49. Wrap the cable around the idler pulley as shown in the cable diagram and in the profile drawing of the assembly (top portion of figure 49).

(8) Attach the spring to the two terminal lugs at the ends of the cable.

(9) Check the assembly by rotating the dial toward the high-frequency end, and then back. Make sure that there is no scraping, binding, or slipping and that the dial tunes properly over the entire range.

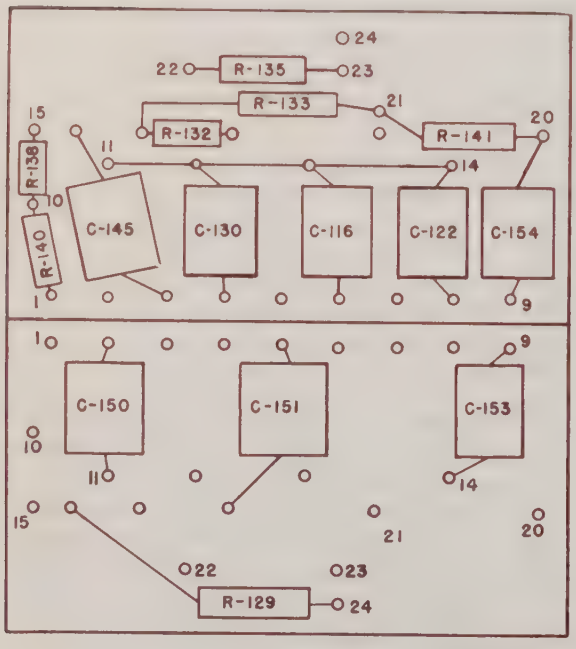



*Figure 50. Terminal board component location diagram.*

*h. Dial-drive Mechanism.* To replace the dial-drive assembly, proceed as follows:

(1) Remove the screw that holds the knob to the dial-drive shaft on the front panel. Remove the knob and the vernier plate.

(2) Remove the screw which holds each of the detent levers to the detent shafts. Remove the levers.

(3) Use a spanner wrench or a pair of long-nosed pliers to remove the nuts that hold the shafts to the panel.

(4) Remove the two screws that hold the pulley holder to the front panel.

(5) Lift the dial-drive mechanism off the rear of the panel; be careful not to loosen the rubber O-ring behind the panel.

(6) To replace, reverse the above procedure.

*i. Replacement of Dial Lamp.* To replace the dial lamp, unscrew the dial lamp cover. This will give access to the dial lamp, which is held in a spring-type socket.

*j. Switches.* Remove panel-mounted switch S202 as follows:

(1) Disconnect the panel from the rest of the assembly.

(2) Remove the dial-drive mechanism as described above.

(3) Unsolder all wires from the switch; tag the leads to enable proper replacement.

(4) Remove the switch knob by removing the knob retaining screw.

(5) Remove the castellated nut, using a spanner wrench or long-nosed pliers.

(6) The switch can now be removed from the rear of the panel. In working the switch away from the panel, make sure not to damage the switch.

(7) When replacing the switch, see that the key on the switch fits into the keying hole on the panel. Be careful when handling the switch, since the wafer is fragile. Examine contacts to be sure that they are made properly and that the switch turns freely to its four positions. Note that the two end positions of the switch are spring-loaded and check to see that each switch is returned from each of its end positions to the adjacent inner position.

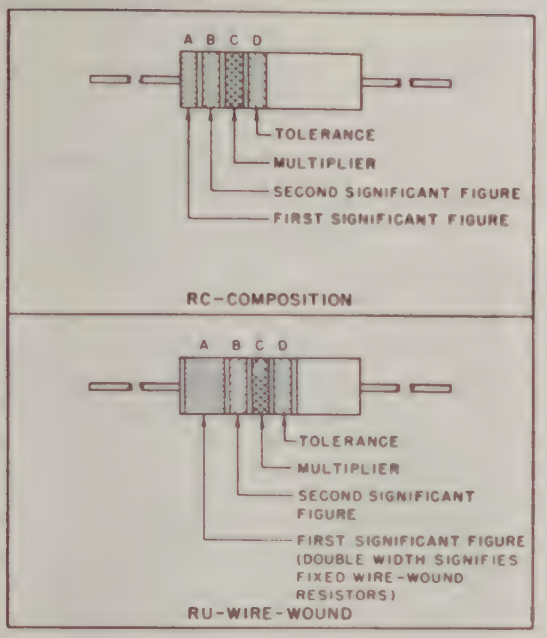
(8) Restore the mounting nut and the knob.

(9) Resolder all connections and check against the schematic diagrams (fig. 53 and 54). Clean away all solder drops.

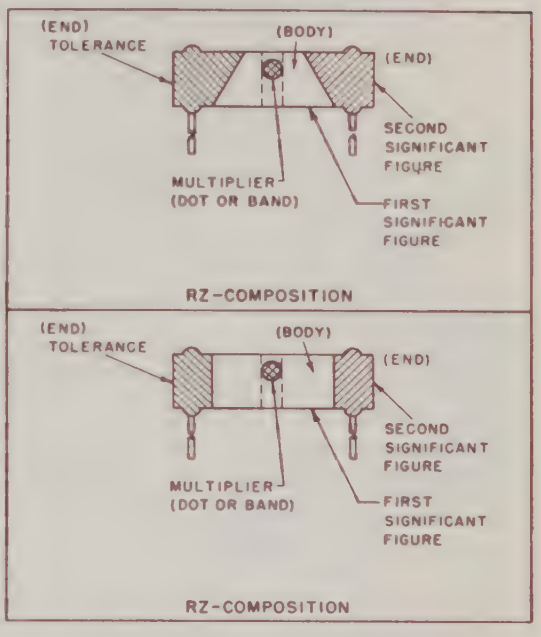
(10) Replace the pulley holder.

## RESISTOR COLOR CODE MARKING
## (MIL-STD RESISTORS)

### AXIAL-LEAD RESISTORS (INSULATED)




### RADIAL-LEAD RESISTORS (UNINSULATED)




## RESISTOR COLOR CODE

| BAND A OR BODY* | | BAND B OR END* | | BAND C OR DOT OR BAND* | | BAND D OR END* | |
|---|---|---|---|---|---|---|---|
| COLOR | FIRST SIGNIFICANT FIGURE | COLOR | SECOND SIGNIFICANT FIGURE | COLOR | MULTIPLIER | COLOR | RESISTANCE TOLERANCE (PERCENT) |
| BLACK | 0 | BLACK | 0 | BLACK | 1 | BODY | ± 20 |
| BROWN | 1 | BROWN | 1 | BROWN | 10 | SILVER | ± 10 |
| RED | 2 | RED | 2 | RED | 100 | GOLD | ± 5 |
| ORANGE | 3 | ORANGE | 3 | ORANGE | 1,000 | | |
| YELLOW | 4 | YELLOW | 4 | YELLOW | 10,000 | | |
| GREEN | 5 | GREEN | 5 | GREEN | 100,000 | | |
| BLUE | 6 | BLUE | 6 | BLUE | 1,000,000 | | |
| PURPLE (VIOLET) | 7 | PURPLE (VIOLET) | 7 | | | | |
| GRAY | 8 | GRAY | 8 | GOLD | 0.1 | | |
| WHITE | 9 | WHITE | 9 | SILVER | 0.01 | | |

* FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

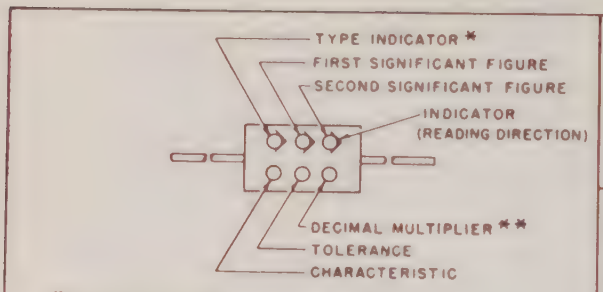
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-RI

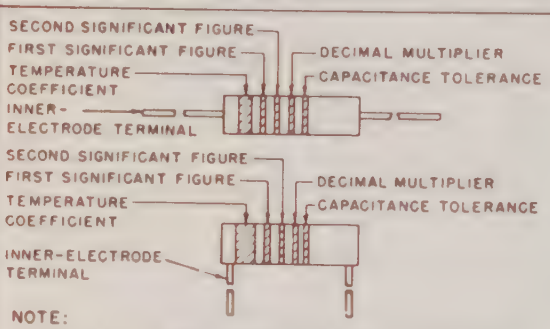
*Figure 51. MIL-STD resistor color code chart.*

## CAPACITOR COLOR CODE MARKING
## (MIL-STD CAPACITORS)



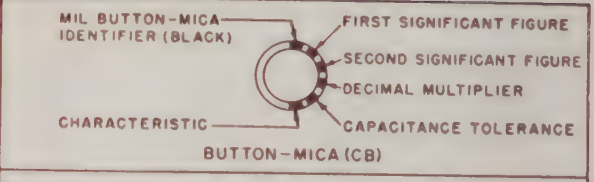

* BLACK DOT MICA DIELECTRIC
SILVER DOT PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE

MICA (CM) AND PAPER (CN)

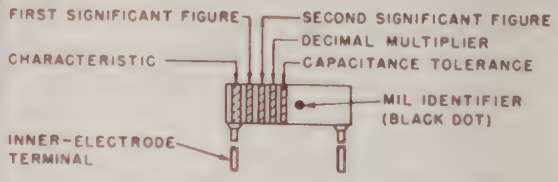


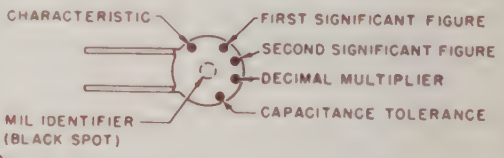

NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS, TEMPERATURE COEFFICIENT MARKING IS LARGER

CERAMIC-TEMPERATURE COMPENSATING (CC)




BUTTON-MICA (CB)




NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE, CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE. YELLOW, +100%, -20%

CERAMIC-GENERAL PURPOSE (CK)

## CAPACITOR COLOR CODE

| COLOR | SIG FIG. | MULTIPLIER | | CHARACTERISTIC[1] | | | | TOLERANCE [2] | | | | | TEMPERATURE COEFFICIENT (UUF/UF/°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DECIMAL | NUMBER OF ZEROS | CM | CN | CB | CK | CM | CN | CB | CC | | |
| | | | | | | | | | | | OVER 10UUF | 10UUF OR LESS | CC |
| BLACK | 0 | 1 | NONE | | A | | | 20 | 20 | 20 | 20 | 2 | ZERO |
| BROWN | 1 | 10 | 1 | B | E | B | W | | | | 1 | | -30 |
| RED | 2 | 100 | 2 | C | H | | X | 2 | | 2 | 2 | | -80 |
| ORANGE | 3 | 1,000 | 3 | D | J | D | | | 30 | | | | -150 |
| YELLOW | 4 | 10,000 | 4 | E | P | | | | | | | | -220 |
| GREEN | 5 | | 5 | F | R | | | | | | 5 | 0.5 | -330 |
| BLUE | 6 | | 6 | | S | | | | | | | | -470 |
| PURPLE (VIOLET) | 7 | | 7 | | T | W | | | | | | | -750 |
| GRAY | 8 | | 8 | | | X | | | | | | 0.25 | +30 |
| WHITE | 9 | | 9 | | | | | | | | 10 | 1 | -330(±500) [3] |
| GOLD | | 0.1 | | | | | | 5 | | 5 | | | +100 |
| SILVER | | 0.01 | | | | | | 10 | 10 | 10 | | | |

1 LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2 IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION

STD-CI

*Figure 52. MIL-STD capacitor color code chart.*

*k. Terminal Board.* The terminal board on the IF chasis (fig. 43) mounts resistors and capacitors. Figure 50 shows the location of components on that terminal board. Components mounted on that side of the board facing toward the outside of the panel-and-chassis assembly can be replaced without removing the board. To gain access to components mounted on the side of the board facing toward the chassis, remove the two mounting screws which hold the brackets to the chassis and tilt the terminal board back. After the defective component has been replaced, remount the board.

*l. Tubes.* A tube puller is provided to permit removal of tubes from their sockets. This tube puller is mounted at the rear of the RF chassis (fig. 45). To remove a tube, remove the tube shield and then, using a tube puller, remove the tube from its socket. Press the puller well over the tube and pull in a direction perpendicular to the chassis. Avoid jiggling or rocking the tube in its socket to prevent damage to the prongs. Label any tube as soon as it is removed so that it can be replaced in its proper socket. Tube reference symbols are stamped on the chassis.

*m. Circuit Label.* A circuit label, rolled up in a compartment on the rear of the RF chassis, is provided to permit identification of electrical parts and circuit components to be repaired or replaced. Replace the circuit label in its compartment after the repair of the equipment has been completed.

## 67. Reassembling Equipment

In general, the procedure for reassembling the equipment follows the reverse of the procedure for disassembling the unit (par. 62). The recommended order is to attach the RF chassis to the front panel first, then attach the IF chassis to the panel. Next, reattach the backplate, restore the bracing screws, and reattach all connectors. This procedure is outlined in *a* through *e* below.

*a. RF Chassis.*

(1) Set the dial to its lowest frequency setting.

(2) Place the front panel face down. Visually line up the RF chassis over the front panel and drop it in place so that the projections on the chassis fall to the right of the projections from the rear left of the front panel and the capacitor shaft fits into the coupling collar. Rotate the capacitor shaft until the tapered hole in the coupling on the capacitor shaft lines up with the threaded hole on the coupling collar on the large pulley. Shift the chassis back and forth slightly to achieve proper alinement. When proper alinement of the two holes is achieved, the setting of the dial will correspond to the setting of the capacitor plates. Insert and tighten the tapered setscrew.

(3) Insert and tighten the two large screws that hold the front panel and RF chassis together. Slightly shift the RF panel back and forth as required to obtain proper alinement. Tighten the screws.

*b IF Chassis.*

(1) Line up the IF chassis over the front panel and drop it in place so that the projections on the chassis fall to the left of the projections from the rear right of the front panel.

(2) Insert and tighten the two screws that hold the front panel and IF chassis together. Slightly shift the IF panel back and forth as required to obtain proper alinement of the mounting holes.

*c. Backplate.*

(1) Attach the backplate to the rear of the chassis assembly so that the edges of the chassis fit into the slots of the backplate and the large captive bolts in the corners of the backplate line up with the mounting holes on the chassis.

(2) Tighten the bolts.

*d. Connectors.* Reattach the connectors, as follows:

(1) Reattach multiconnector P202 on the cable from the panel to connector J101 on the IF chassis.

(2) Reattach multiconnector P201 on the cable from the panel to connector J1 on the RF chassis.

(3) Reconnect pin connector P2 from the RF chassis to the ANT connector J201 on the panel.

(4) Reconnect pin connector P1 from the plate of V11 on the RF chassis to pin 2 of T101 on the IF chassis.

*e. Plug-in Components.*

(1) Make sure that all tubes are installed and that they are seated firmly in their sockets. See that all tube shields are installed.

(2) Make sure that all crystals are installed and seated firmly in their sockets. Check tightness of crystal retaining springs.

Crystals Y1 and Y2 are located as the center and front, respectively, of the RF chassis. Crystals Y101 and Y102 are located at the rear and front, respectively, of the IF chassis.

## 68. Lubrication

Receiver-Transmitter RT-70(*)/GRC described in this manual does not require lubrication in the field. Certain parts are self-lubricated. Included in this category are the dial-drive mechanism and the O-ring seals on the shaft of panel-mounted components.

# Section III. ALINEMENT PROCEDURES

## 69. Test Equipment Required for Alinement

The test equipment required for alinement of the receiver-transmitter is the same as that listed in paragraph 46.

## 70. Initial Procedures

*a. Initial Switch and Control Settings.* Unless otherwise specified, the controls should be set as follows:

| Control | Position |
|---|---|
| SQUELCH | Extreme counterclockwise (OFF). |
| VOLUME | Extreme clockwise (maximum gain). |
| ANT ADJ-DIAL LIGHT (ON OFF)-CAL. | DIAL LIGHT OFF (or ON). |
| TANK-VEH-FIELD | VEH or FIELD, depending on whether a vibrator power supply and AF Amplifier AM-65/GRC or Case CY-590/GR and dry batteries are used to supply power to the unit under test. |

*b. Test Connections.* Unless otherwise called for under the alinement procedures, the test connections are the same as described in paragraph 48.

## 71. Checks and Adjustment of Calibrate and Beat Oscillators

*a. Adjustment of Calibrate Oscillator V7.*

(1) Connect vacuum tube voltmeter M1 between the grid (pin 6) of tube V7 and the chassis.

(2) Set the test switch in the CAL position.

(3) Adjust plate circuit trimmer capacitor C48 (fig. 5) for a maximum dc voltage.

*Requirement:* The maximum deflection of the meter should be approximately −25 volts dc.

(4) Reduce the capacity of the trimmer until the voltmeter indicates .7 of the maximum reading obtained in (3) above. For example, if the reading in (3) above is 20 volts dc, the new reading should be 20 x .7 = 14.0 volts dc.

(5) Turn the test switch to the ANT ADJ position and recheck as above.

(6) Disconnect the vacuum tube voltmeter and return the test switch to one of the DIAL LIGHT positions.

(7) If trouble with the calibrate oscillator is indicated, refer to paragraph 38.

*b. Check of 1.4-mc Beat Oscillator in RT-70/GRC (part of V106).*

(1) Connect vacuum tube voltmeter M1 between the grid (pin 6) of V106 and chassis.

(2) Turn the test switch to the CAL position and observe whether the following requirement is met.

*Requirement:* The meter should read approximately −4.0 volts.

(3) If the above requirement is not met, and trouble with the beat oscillator is indicated, refer to paragraph 53.

## 72. Receiver Alinement

*a. Test Signal Calibration (Reference Level A).*

(1) Connect the 1.4-mc test signal generator (G1) in series with a .01-μf capacitor between test point E103 (fig. 44) and chassis.

(2) Connect meter M1 between test point E104 (fig. 44) and chassis. Hereafter, this meter will be referred to as the LIMITER METER.

(3) Adjust the test signal frequency for zero beat with the 1.4-mc beat oscillator. To do that:

(*a*) Turn the test switch on the front panel to the CAL position. This is a spring-return position.

(*b*) Adjust the test signal frequency to 1.4 mc until a zero-beat note is heard in the headset.

(c) Return the test switch to the DIAL LIGHT position.

(4) Adjust the test signal level to .15 volt and observe the LIMITER METER reading. The meter reading obtained under these conditions will, hereafter, be referred to as REFERENCE A. In subsequent checks the test signal generator output level will be adjusted to obtain this reading of the meter.

*Requirement:* The LIMITER METER should read approximately −14 volts dc.

(5) If the above requirement is not met, V104 and V105 should be checked and replaced if found defective. If necessary, make point-to-point resistance and voltage measurements to locate a defective component. After repairing the fault and obtaining the required reading, proceed with the tests and adjustments described in *b* through *g* below. If the requirement is still not met, T105 may be misalined. Check as indicated in *b* below.

*b. Receiver Alinement Procedure.* Correct signal generator G1 and meter M1 where indicated.

| Stage or circuit | Receiver dial setting | Signal generator frequency | Signal injected | Meter connected | Adjustment | Dc voltage indication |
|---|---|---|---|---|---|---|
| Second limiter | Any | 1.4 mc | E103. Blue test point. | E104. Red test point. | T105 | Maximum voltage |
| First limiter | Any | 1.4 mc | E102. Black test point. | E104. Red test point. | T104 | Maximum voltage |
| Fourth IF amplifier | Any | 1.4 mc | E101. White test point. | E104. Red test point. | T103 | Maximum voltage |
| Discriminat9r | Any | 1.4 mc | E101. White test point. | E106. Yellow test point. | T106 | 1. Detune secondary<br>2. Tune primary to maximum<br>3. Retune secondary to zero |
| Second receiver oscillator | Any | 15 mc | E101. White test point. | E104. Red test point. | None | Dc voltage |
| Third IF amplifier | Any | 15 mc | Pin 6 9f V101 | E104. Red test point. | T102 | Maximum voltage |
| Second IF amplifier | Any | 15 mc | Pin 6 of V11 | E104. Red test point. | T101 | Maximum voltage |
| First IF amplifier | Any | 15 mc | Pin 6 of V10 | E104. Red test point. | T10 | Maximum voltage |
| First receiver mixer | Any | 15 mc | Pin 6 of V9 | E104. Red test point. | T9 | Maximum voltage |
| Variable oscillator V2 | 58 mc | 58 mc | Antenna | E104. Red test point. | C4 | Maximum voltage |
| | 47 mc | 47 mc | Antenna | E104. Red test point. | L3 | Maximum voltage. |
| RF amplifier plate circuit. (Repeat this step until no further increase is noticed. | 58 mc | 58 mc | Antenna | E104. Red test point. | C56 | Maximum voltage. |
| | 47 mc | 47 mc | Antenna | E104. Red test point. | L23 | Maximum voltage. |
| Antenna circuit | Any operating frequency | Operating frequency | Antenna | E104. Red test point. | C41 | Maximum voltage. |

*c. Calibration of 58-mc Point on Dial.* The following adjustments are to insure that the dial is tuned accurately to 58 mc (58th harmonic frequency of calibrate oscillator V7), *which may not result from the preceding steps if the calibration of the signal generator is not exact.*

(1) Restore crystal Y2 into its socket.

(2) Disconnect the signal generator.

(3) Turn the test switch on the receiver-transmitter panel to the CAL position, and note whether the following requirement is met.

*Requirement:* A zero-beat note should be heard.

(4) If the above requirement is not met, proceed as follows:

(*a*) Turn the dial to the right of zero and then to the left of zero on the vernier plate, until the zero-beat note is tuned in in each case. Note that the beat note will be found on each side of zero. However, the desired (58 mc) beat note is the one which occurs at the vernier plate setting nearest the zero.

(*b*) Tune for the zero-beat note which occurs for the vernier plate setting nearest to zero which is the 58-mc beat note.

(*c*) Adjust C4 (fig. 6) slightly, and turn the tuning knob slightly to bring in the zero-beat note again. Note whether the beat note now occurs closer to zero or further away from zero.

(*d*) If the beat note is now further away from zero, reverse the direction of turning C4. If the beat note is closer to zero the correct direction or rotation of C4 has been selected. Continue the adjustment of C4 and turn the dial until the zero-beat note occurs when the vernier zero lines up with the calibration marker on the panel. When this occurs, the variable oscillator will have been accurately calibrated against the 58-mc setting of the dial.

*d. Calibration 47-mc Point on Dial.*

(1) Rotate the dial in the direction of the LF end of its tuning range, keeping the test switch in the CAL position.

(2) Count off 11 beat notes, starting with 57 as beat note number 1. Then 11th beat note corresponds to the 47th harmonic of the 1-mc calibrate oscillator, and represents a frequency of 47 mc.

(3) Observe whether the following requirement is met.

*Requirement:* If the dial calibration is correct, the hairline on the dial will coincide with the 47 marker, and the zero on the vernier plate will coincide with the calibration marker on the panel. A tolerance of $\pm 5$ kc is permitted.

(4) If the above requirement is met, proceed directly to the instructions in *e* (1) and (2) below. If the requirement is not met, proceed with the following adjustments and, if necessary, with the instructions in (5) below, before continuing with (*a*) through (*c*) below.

(*a*) Adjust the tuning slug of coil L3 (fig. 5) in tuning unit T3, in or out, about one-fourth turn.

(*b*) Retune the knob to again obtain the zero-beat note.

(*c*) Observe whether the zero-beat note occurs at a point on the vernier plate, closer to or further away from the required position and continue to adjust the tuning slug accordingly until the requirement is met as indicated in (3) above.

(5) If the 11th beat note cannot be reached as in (2) above, or if the adjustments of (4) above fail to produce the results specified in the requirement in (3) above, the coupling between the dial drive and the gang capacitor has probably been disturbed and the capacitor cannot cover the entire tuning range of the set. Readjustment is then necessary. The procedure for doing this is as follows:

(*a*) Look through the hole on top of gang capacitor C10 (fig. 45). Rotate the dial to the extreme LF end of its range, until the stop is reached.

(*b*) Observe whether the rotor plates are meshed with the stator plates as described in the following requirement:

*Requirement:* The edges of the rotor plates should be one-thirty-seconds inch in the reduced capacity (open) direction from the edges of the stator plates.

(*c*) If this requirement is not met, loosen the two outer set screws on the coupling collar. These allen setscrews hold the brass coupling to the gang capacitor

shaft. The screws are identified by *red dots*.

(*d*) Carefully rotate C10 until the requirement stated above is met. Be careful not to touch the adjustment of the front dial while the setscrews are loose. Note that the capacitor may be rotated by means of the shaft end at the rear of the capacitor. Tighten the setscrews.

(*e*) Repeat *c* and *d* above to check whether the variable gang capacitor now covers the entire tuning range of the receiver-transmitter. The procedures of *c* and *d* above may have to be repeated several times before all requirements are met.

*e. Recheck of Dial Calibration at 58-mc Point.* After the requirements in *c* and *d* are met, the dial will be in the 47-mc position. Recheck the dial calibration at the 58-mc position as follows:

(1) Rotate the dial back toward the HF end, holding the test switch in the CAL position. Count off 11 beats, starting with that at 48 as beat note number 1.

(2) Observe the dial and vernier plate settings when the 11th note has been reached.

*Requirement:* When the 11th beat note has been reached, the main dial hairline should be at 58, and the zero on the vernier plate should be within ±5 kc of the calibration marker on the panel.

(3) If the above requirement is met, proceed with *f* below. Otherwise, repeat *c*, and *d*, above, and (1) and (2) above, until the dial calibration requirements at the LF end of the dial (47 mc) and at the HF end of the dial (58 mc) are both met.

*f. Dial Calibration at Intermediate Integral Mc Points.* After the low and high ends of the dial have been calibrated as described in *c* and *d* above, and the calibration at the high end rechecked as described in *e* above, it is necessary to determine whether the calibration of the dial at intermediate points follows a straight-line curve. The dial calibration follows a straight-line curve if the zero-beat note for each integral mc point on the dial is obtained when the vernier plate zero is within one-fourth of a division (25 kc) of the calibration marker on the panel. Adjustment of the calibration is accomplished by bending the segments of the segmented plates mounted on the rear end of the gang capacitor shaft. The procedure is as follows:

(1) Hold the test switch in the CAL position, and turn the dial to each successive position at which a zero-beat note is heard, starting with position 57, and continuing toward the LF end of the dial.

(2) For each zero-beat note, observe the position of the dial with respect to the hairline, and of the vernier plate zero with respect to the panel marker.

*Requirement:* Each zero-beat note should occur when the hairline coincides with the correct (see note below) mc mark on the main dial. The zero on the vernier plate should be not more than one-fourth of a division (25 kc) away from the calibration marker on the panel.

*Note.* To determine whether a particular beat note occurs at the correct mc position of the dial (for example, whether the 52d harmonic or 52 mc is actually selected when the dial is at or near 52), assign a sequence number to each beat note in the order of its occurrence. Start with the first beat note heard after turning away from 58. Assign number 1 to that beat note. Assign number 2 to the next beat note, etc. Substract the sequence number from 58. This will give the correct dial position number. For exaplel, the 6th beat note occurring after turning away from 58 corresponds to the 52d harmonic of the beat oscillator (58–6) and should therefore occur when the dial hairline is at or near 52.

(3) If the above requirements are met, proceed with (*a*) below. Otherwise, make the adjustment described in *b* above until requirements are met.

(*a*) Rotate the dial to the highest frequency zero-beat note at which the dial calibration requirement in (2) above is not met.

(*b*) Bend slightly and carefully that segment of the outer slotted plate (calibration adjustment plate mounted on the rear end of the capacitor shaft (fig. 6)) which corresponds to the particular setting of the dial. To identify the segment which corresponds to the particular setting of the dial, look for the segment which meshes with the small triangular fixed section mounted on projections from the gang capacitor wall.

***Caution:*** Be very careful not to break off the segment by applying excessive pressure. Bend the segment a little at a time. Check the results of the bending before continuing to bend the segment further.

(*c*) Bending the segment will cause the zero-beat note to shift to another position on the vernier plate. Turn the tuning knob until the zero-beat note reappears, and observe whether the zero on the vernier plate is now closer to or further away from the calibration marker on the panel. If the zero beat is closer to the zero position of the vernier plate, the segment was bent in the correct direction. Otherwise, repeat by bending the segment in the opposite direction.

(*d*) Continue to bend the segment and adjust the tuning knob until the zero-beat note occurs when the zero on the vernier plate is within one-fourth of a division (25 kc) of the calibration marker on the panel, for the particular integral mc setting of the dial.

*Note.* Bending one segment of the slotted calibration plates may affect the adjacent intergral mc frequency setting of the dial. Therefore, upon completion of the adjustment at any one mc position of the dial, recheck the settings involving the adjacent segments in (1) and (2) above. If necessary, adjust (3) above).

(*e*) Repeat (3) above, for each integral mc setting of the dial at which the calibration requirement in (3) above is not met. Work in the order of descending mc settings of the dial.

***Caution:*** Do not bend segments which mesh at 58 and 47 mc.

(4) After completing the adjustments at all mc segments at which the calibration requirement has not been met, recheck the entire dial as described in (1) and (2) above and, if necessary, repeat the adjustments ((3) above) until the calibration requirements are met for all integral settings on the dial.

*g. Antenna Circuit Alinement.* For the following adjustments, retain the test connections given above. Note that once the antenna circuits have been alined for the receiver, it will not be necessary to realine it for the transmitter. However, when the unit being tested is restored to the vehicle or to the portable installation, and is equipped with the antenna with which it is to operate, readjustment of the trimmer capacitor C41, accessible from the top of the outer case when the cap is removed, will be necessary (in tanks, use a special alinement tool, Sig C stock No. 6Q335–7).

*Note.* For proper operation of the equipment, it is necessary that the oscillator be properly aligned and the dial be properly calibrated. For this reason, the above procedure stresses repeated checking until all requirements are met.

(1) Adjust the test signal frequency to 58.0 mc and tune in with receiver-transmitter dial until the LIMITER METER shows a peak reading. Adjust the test signal level to obtain the REFERENCE B reading on the LIMITER METER.

(2) Adjust trimmer capacitor C41 until the LIMITER METER shows a peak reading. Note that C41 has the funnel-shaped adjustment control. When the panel-and-chassis assembly is installed in the case, this control is accessible through the hole at the top of the case after the cap has been removed. A notch on the funnel-shaped control lines up with a mark on the outer case when capacitor C41 is set for maximum capacity (figs. 1 and 5).

(3) Adjust the test signal frequency to 47.0 mc and tune in with receiver-transmitter dial until the LIMITER METER shows a peak reading. Adjust the test signal level to obtain REFERENCE B reading on the LIMITER METER.

(4) To check whether antenna coil L18 needs adjustment, vary trimmer capacitor C41 slightly away from its setting arrived at in (2) above. Vary it in the clockwise and in the counterclockwise direction. Observe the LIMITER METER when doing this.

(*a*) If the LIMITER METER reading shows a tendency to decrease, the coil does not need adjustment. Simply restore the trimmer capacitor to its original adjustment. If the LIMITER METER reading shows a tendency to increase as the capacitor control is varied, the coil needs adjustment.

(*b*) Using a nonmetallic tool, spread or compress the turns of coil L18 until a peak reading is obtained inthe LIMITER METER. Coil L18 in the RF coil compartment is part of T7. Access to the coil turns is obtainable through a slot at the front end of the RF coil compartment (fig. 46). To gain access to the

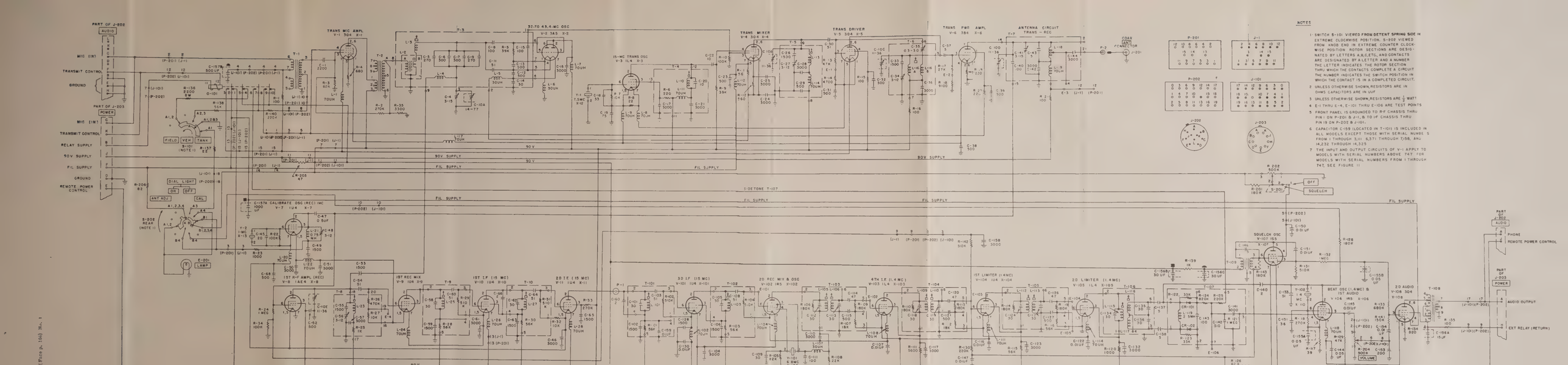

NOTES
1 SWITCH S-101 VIEWED FROM DETENT SPRING SIDE IN EXTREME CLOCKWISE POSITION. S-202 VIEWED FROM KNOB END IN EXTREME COUNTER CLOCKWISE POSITION. ROTOR SECTIONS ARE DESIGNATED BY LETTERS A,B,C,ETC., AND CONTACTS ARE DESIGNATED BY A LETTER AND A NUMBER THE LETTER INDICATES THE ROTOR SECTION THRU WHICH THE CONTACTS COMPLETE A CIRCUIT THE NUMBER INDICATES THE SWITCH POSITION IN WHICH THE CONTACT IS IN A COMPLETED CIRCUIT.
2 UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS CAPACITORS ARE IN UUF
3 UNLESS OTHERWISE SHOWN, RESISTORS ARE ½ WATT
4 E-1 THRU E-4, E-101 THRU E-106 ARE TEST POINTS
5 FRONT PANEL IS GROUNDED TO R-F CHASSIS THRU PIN 1 ON P-201 & J-1, & TO I-F CHASSIS THRU PIN 19 ON P-202 & J-101.
6 CAPACITOR C-159 (LOCATED IN T-101) IS INCLUDED IN ALL MODELS EXCEPT THOSE WITH SERIAL NUMBERS FROM 1 THROUGH 3,111; 6,371 THROUGH 7,158, AND 14,232 THROUGH 14,325
7 THE INPUT AND OUTPUT CIRCUITS OF V-1 APPLY TO MODELS WITH SERIAL NUMBERS ABOVE 747. FOR MODELS WITH SERIAL NUMBERS FROM 1 THROUGH 747, SEE FIGURE 11
PART OF J-202
AUDIO
MIC (IN)
TRANSMIT CONTROL
GROUND
PART OF J-203
POWER
MIC (IN)
TRANSMIT CONTROL
RELAY SUPPLY
90 V SUPPLY
FIL SUPPLY
GROUND
REMOTE POWER CONTROL
TRANS MIC AMPL V-1 304 X-1
32-70 43.4-MC OSC V-2 345 X-2
15-MC TRANS OSC V-3 1L4 X-3
TRANS MIXER V-4 304 X-4
TRANS DRIVER V-5 304 X-5
TRANS PWR AMPL V-6 384 X-6
ANTENNA CIRCUIT TRANS - REC
COAX ANT CONNECTOR
P-201
J-101
P-202
J-102
J-203
FIELD
VEH
TANK
DIAL LIGHT
ON
OFF
ANT ADJ
CAL
S-202 REAR (NOTE 1)
E-201 LAMP
C-157A CALIBRATE OSC (REC) IMC V-7 1U4 X-7
1ST R-F AMPL (REC) V-8 1AE4 X-8
1ST REC MIX V-9 1U4 X-9
1ST I.F. (15 MC) V-10 1U4 X-10
2D I.F. (15 MC) V-11 1U4 X-11
3D I.F. (15 MC) V-101 1U4 X-101
2D REC MIX & OSC V-102 1R5 X-102
4TH I.F. (1.4 MC) V-103 1L4 X-103
1ST LIMITER (1.4MC) V-104 1U4 X-104
2D LIMITER (1.4MC) V-105 1L4 X-105
SQUELCH OSC V-107 1S5
BEAT OSC (1.4MC) & 1ST AUDIO V-106 1R5 X-106
2D AUDIO V-108 3O4
SIDETONE T-107
OFF
SQUELCH
S-201
PHONE
REMOTE POWER CONTROL
AUDIO OUTPUT
EXT RELAY (RETURN)
90 V SUPPLY
FIL SUPPLY
REMOTE POWER CONTROL

*Figure 68. Receiver-Transmitter RT-70/GRC, schematic diagram.*

slot, it is necessary to disengage the IF chassis from the rest of the panel-and-chassis assembly.

(5) Repeat (1) through (4) above until no further improvement in peaking is obtainable.

*Note.* In actual operation, any mistracking at any point on the dial due to the coil may be taken care of by adjusting trimmer capacitor C41 to obtain a peak reading on the LIMITER METER, for that dial setting.

## 73. Transmitter Alinement Procedure

*a.* In the transmitter alinement procedure outlined in the following chart, it is assumed that the common 32- to 43.4-mc variable oscillator has been checked and alined as described in paragraph 72. Connect meter M1 where indicated.

*Note.* The antenna circuit has been alined in connection with the alinement of the receiver RF circuits (par. 72). An alternative method of adjustment of trimmer capacitor C41 for the 58-mc setting of the dial and of L18 for LF end of the dial is to follow the procedure outlined in paragraph 72; observe the peaking adjustment of the RF meter in the dummy antenna load. Note that once the antenna circuit has been alined for either the transmitter or the receiver, further alinement for the other circuit is not necessary. However, when the unit under test is installed in the vehicle or other installation, a readjustment of antenna capacitor C41 will be necessary to match the antenna circuit to the antenna actually to be used in the installation. In this case, it is necessary to tune C41 for maximum noise quieting in the receiver, with the test switch in the ANT ADJ position, and the SQUELCH control turned off.

| Stage | Dial setting | Meter connected | Component adjusted | Dc voltage indication |
|---|---|---|---|---|
| Variable oscillator V2. | | | | Done as part of receiver section. |
| 7.5-mc crystal oscillator. | Any | E1 to pin 1 or 7 of V5 | L10 | Maximum voltage. |
| Transmitter mixer (repeat this step until no increase is noted). | 58 mc<br>47 mc | E1 to pin 1 or 7 of V5 | C27<br>L13 | Maximum voltage.<br>Maximum voltage. |
| Transmitter driver (repeat this step until no further increase is noted). | 58 mc<br>47 mc | E2 to chassis<br>E2 to chassis | C34<br>L16A | Maximum voltage.<br>Maximum voltage. |
| Power amplifier antenna circuit | Any operating frequency. | Across R21 | C41 | Minimum voltage. |

*Note.* Transmitter must be keyed and the dummy antenna load connected.

*b.* See that the plate current of power amplifier tube V6 is of the correct value as follows:

(1) Connect vacuum tube voltmeter M1 between terminals 1 and 3 on the side wall of T7 (fig. 48). These terminals are accessible from the bottom of the panel-and-chassis assembly and are stamped with numbers 1 and 3, respectively.

(2) Operate the microphone push-to-talk switch, and observe the meter reading.

*Requirement:* The meter should read approximately 1.7 volts to indicate that approximately 17 ma (milliamperes) of plate current is being drawn by V6.

## 74. Neutralization Adjustment

It is not necessary to adjust neutralizing capacitor C35 during normal alinement of the transmitter circuits. These adjustments should not be attempted unless it is certain that neutralization is required, and then only by experienced maintenance personnel. Neutralization is adjusted at the factory, and the neutralization controls are sealed with red glyptal. Unless major repairs have been made on the transmitter circuits, neutralization should not be required.

*a. Neutralization Check.* If the adjustments of C27 and C34, as outlined in paragraph 73, seem to be interdependent (adjustment of C34 affects tuning of C27), then the transmitter is not neutralized correctly. It is then necessary to proceed as in *b* below.

*b. Neutralization Adjustment.*

(1) Remove crystal Y1 from socket.

(2) Connect vacuum tube voltmeter M1 between test point E2 (fig. 39). and chassis.

(3) Turn the dial to the 58.0-mc position.

(4) Turn on power, and operate the microphone push-to-talk switch.

(5) Adjust neutralizing capacitor C35 (fig. 47) for a minimum voltage indication on the meter. This capacitor is located inside

the RF coil compartment. Transmitter is now neutralized.

### 75. Identification of Test Points

*a.* The test points of the RF chassis, E1 through E4, are feedthrough insulators, mounted on the sides of the RF coil compartment, and accessible from the top or bottom of the panel-and-chassis assembly. Their electrical locations are shown in figures 53 and 54.

*b.* The test points of the IF chassis, E101 through E106, are solder lug terminals, distributed around the edge of the chassis. For identification purposes, a color code has been assigned to the insulation (spaghetti) covering the major portion of each test point. The color code data are included in the following chart.

| Test point | Insulation color | Circuit association |
|---|---|---|
| E101 | White | Grid circuit V102. |
| E102 | Black | Grid circuit V103. |
| E103 | Blue | Grid circuit V104. |
| E104 | Red | Grid circuit V105. |
| E105 | Green | Grid circuit V005. |
| E106 | Yellow | Discriminator T107. |

## Section IV. FINAL TESTS

*Note.* After the receiver-transmitter has been repaired and alined, as described in paragraphs 44 through 75, the unit should be fit for return to service. To make sure that this is the case, repeat the operational and sectionalization checks outlined in paragraphs 52 through 56. Other faults may thus come to light. Make the necessary repairs. If the unit operates as required in paragraphs 52 through 56, perform the tests outlined in paragraphs 77 through 80. These test are *double-checked* to make sure that the most important functional requirements of the unit are met, and that it is therefore safe to return the unit to service.

### 76. Overall Receiver Sensitivity

Connect the test equipment as indicated in paragraphs 44 through 60 with the following exceptions:

*a.* Connect RF signal generator G2 to the ANT connector on the front panel.

*b.* Connect ac voltmeter M2, shunted by a 600-ohm, ½-watt resistor, to the audio output terminals.

*c.* Set the controls on the front panel as follows:

| Controls | Position |
|---|---|
| SQUELCH | OFF |
| ANT ADJ-DIAL LIGHT (ON-OFF)—CAL switch. | DIAL LIGHT OFF. |
| TANK-VEH-FIELD switch (internal). | VEH or FIELD, depending on whether AF Amplifier AM-65/GRC and a vibrator power supply, or Case CY-590/GR and dry batteries are used to supply power. |
| VOLUME control | Extreme clockwise. |

*d.* Adjust the frequency of the TENTH-MCS dial and of the signal generator to 47.0 mc.

*e.* Adjust the signal generator output level to 1.0 uv.

*f.* Apply FM to the signal generator. The modulation frequency should be 1,000 cycles at ±15-kc deviation.

*g.* Adjust the VOLUME control on the front panel until voltmeter M2 reads 2.45 rms. (This voltage reading is equivalent to 10 mw.)

*h.* Now remove the modulation from the signal generator frequency.

*i.* Note the voltmeter reading.

*Requirement:* The voltmeter reading should not be greater than .245 volt (or 20 db below 2.45 volts).

*j.* Repeat the steps in *d* through *i* above for each of the RF frequencies, 52.0 mc and 58 mc. The same requirement should be met at each frequency.

*k.* Measurement of current in the squelched audio tube plate circuit (external relay circuit or between H and J of J203) will be made with a resistor and milliammeter in series, the combination being a total series resistance of 1,000 ohms.

(1) *Maximum squelch sensitivity.* With no signal input the squelch control will be adjusted to reduce the squelched audio tube plate current to .4 milliampere or less. Apply an RF signal sufficient to increase the plate current to 4.0 milliamperes. The RF signal required will not exceed 1.0 microvolt.

(2) *Minimum squelch sensitivity.* Rotate the squelch control to its maximum clockwise position. The input signal required to increase the plate current of the squelched audio tube to 4 milliamperes will be not greater than 80 microvolts nor less than 3 microvolts. Reduce the input signal slowly until the plate current of the squelched audio returns to .4 milliampere or less. The input signal required will be not less

than 3 microvolts and will be between 25 and 100 per cent of the maximum squelch value.

*Note.* The readings given in *k* above, were obtained in a screen room. If the squelch test is performed outside a screen room, values given for the RF input signal may be greater.

## 77. Overall Selectivity

*a. Measurements.*

(1) Connect the RF signal generator (G2) to the ANT connector.

(2) Connect limiter meter M1 between test point E104 (grid of V105) and chassis.

(3) Tune the receiver dial to 58 and line up the zero on the vernier plate exactly with the dot (calibration marker) on the panel.

(4) Tune in the RF signal generator frequency exactly to the frequency setting of the receiver. This is done by varying the signal generator frequency at or near 58 mc until the LIMITER METER shows a peak reading.

(5) Adjust the signal generator output level to produce the REFERENCE B (−11 volts) reading on the LIMITER METER. Note the signal generator output level at the REFERENCE B reading.

(6) Now increase the signal generator output level by 6 db (that is, double the output voltage).

(7) Tune the signal generator to a frequency above 58 mc, until the reading obtained in (5) above is again obtained. Note the change in frequency for which this occurs.

(8) Tune the signal generator to a frequency below 58.0 mc until the reading obtained in (5) above (REFERENCE B) is again obtained. Note the change in frequency from center frequency for which this reading occurs.

(9) Compute the sum of the two *changes* in frequency obtained in (7) and (8) above. This is the overall receiver bandwidth at points which are 6 db below the center frequency. The bandwidth should be about 85 kc.

(10) Compute the difference between the two *changes* in frequency noted in (7) and (8) above. This difference, a measure of symmetry, should be not greater than 15 kc.

*b. Analysis.* Incorrect bandwidth is an indication of improper alinement of the receiver. An unsymmetrical selectivity curve (second requirement) indicates a defective component in the tuned circuit, or improper alinement of the double tuned stages of the 1.4-mc IF amplifier, or regeneration in any of the IF or RF circuits. Accordingly, if the measurements made in *a* above show that either one of these defects may exist, recheck the alinement of the receiver stages, as described in paragraph 72. If alinement fails to clear the trouble, look for a defective resistor, bypass capacitor, or tuning coil. The bandwidth check in *c* below need not be performed if the requirements of *a* are met. If these requirements are not met, this check will help to sectionalize the difficulty to the 15-mc if, 1.4-mc IF, or the RF stages.

*c. Overall IF Selectivity (15.0 mc).*

(1) Connect the signal generator (G1) through a .003-$\mu$f capacitor between the grid (pin 6) of receiver first mixer V9 and chassis.

(2) Adjust the signal generator to 15.0 mc by zero-beating with the beat oscillator. Adjust the test signal level to obtain the REFERENCE B reading (−11 volts dc) of the LIMITER METER. Note the level of the signal generator output required to do so.

(3) Raise the signal generator output level by 6 db—that is, double the voltage level of (2) above.

(4) Raise the frequency of the signal generator above 15.0 mc until the REFERENCE B reading of the LIMITER METER is again obtained. Note the change in signal generator frequency for which REFERENCE B is again obtained.

(5) Lower the frequency of the signal generator below 15.0 mc and note the change in frequency for which the REFERENCE B reading is again obtained.

(6) Compute the sum of the two changes in frequencies obtained in (4) and (5). This sum (a measure of bandwidth) should be 85 $\pm$ 10 kc.

(7) Compute the difference between the two changes in frequencies of (4) and (5). This difference (a measure of symmetry) should not exceed 15.0 kc.

(8) If the requirements in (6) and (7) above are not met, check as indicated in *b* above.

## 78. Dial Calibration Check

Check the calibration of the dial at each of the integral mc positions, as described in paragraph 74*e*, and note whether the following requirement is met.

*Requirement:* A beat note should be heard at each mc point of the dial. When the beat note is heard, the zero on the vernier plate should be not more than one-fourth (25 kc) of a division away from the calibration marker (dot) on the panel.

## 79. Receiver Overall Frequency Response

*a.* Connect FM signal generator G2 to the ANT connector. Tune the receiver being tested and the signal generator to 52.0 mc.

*b.* Adjust the test signal level to 10.0 $\mu$v.

*c.* Modulate the test signal with a 1,000-cycle audio tone at $\pm$15-kc deviation.

*d.* Connect AF output meter M4 to the audio output connections on the front panel.

*e.* Connect discriminator meter M1 between test point E106 and chassis.

*f.* Adjust the frequency of the signal generator to obtain a zero deflection on discriminator meter M1.

*g.* Adjust VOLUME control to obtain 10-mw reading on the output meter.

*h.* Leaving the setting of the VOLUME control constant, adjust the modulating frequency of the signal generator to 400, 1,000, 2,000, and 5,000 cycles, successively, maintaining a deviation of $\pm$15 kc for each frequency.

*i.* For each modulating frequency, observe the reading of the output meter.

*Requirement:* The approximate readings at the audio frequencies applied as modulation to RF signal are tabulated below.

| *Audio modulation frequency (cps)* | *AF output meter reading (db)* |
|---|---|
| 400 | 0. |
| 1,000 | 0 (reference, 10 mw). |
| 2,000 | −3. |
| 5,000 | −12. |

*j.* Apply 1,000-cycle modulation to the test signal and turn the VOLUME control to the maximum clockwise position. Observe the reading of the output meter.

*Requirement:* The output meter should read at least 60 mw.

## 80. Check of Modulator Operation

*a. Audio Signal Transmission Check.* These checks involve the use of another Receiver-Transmitter RT–70(*)/GRC, known to be in good operating condition. This receiver-transmitter will be referred to as a test receiver.

(1) Connect audio signal generator G3 to the microphone input terminal of the receiver-transmitter being tested, as illustrated in figure 34. Connect a dummy antenna load to the ANT connector. Connect output meter M4 to the audio terminals of the test receiver. Connect meter M1 to the output of the discriminator test point E106 of the test receiver.

(2) Operate the microphone switch on the unit being tested, and transmit the unmodulated carrier. Measure the transmitter power output across the dummy load.

*Requirement:* The RF meter in the dummy load should read 500 mw.

(3) Tune in the unmodulated carrier from the unit being tested on the receiver being used as a test instrument. Adjust the transmitter frequency to obtain a zero reading on test receiver discriminator meter M1.

(4) Now adjust the audio signal generator to deliver a 1,000-cycle signal at a level of .25 volt to the microphone terminals of the unit being tested.

(5) Measure the audio output level at the output terminals of the test receiver, setting its volume control for maximum output. Assuming that another Receiver-Transmitter RT–70(*)/GRC is being used, the output level should be at least 60 mw. (If another receiver is being used, the output level should be the normal output level for the receiver.)

(6) Adjust the volume control of the test receiver to obtain an output reading of 10 mw.

7) Now change the modulating frequency to 400 cycles and then to 2,000 cycles. In each case, the input level should be .25 volt. For each modulating frequency, read the output meter connected to the test receiver.

*Requirement:* The approximate reading at each test frequency should be tabulated below.

| *Audio frequency (cps)* | *Output meter reading (db)* |
|---|---|
| 400 | −10. |
| 1,000 | 0 (reference, 10 mw). |
| 2,000 | +1.5. |

*Note.* The above figures assume that another Receiver Transmitter RT 70(*)/GRC is being used for the test and has been tested and established as being in good operating condition. If this assumption is not true, only qualitative checks can be made, or the requirements reinterpreted to correspond to the test receiver characteristics.

*b. Speech Transmission Check.* Replace the AF output meter with a pair of headphones, and the audio signal generator (*a* above) with a microphone. Operate the microphone push-to-talk switch, and talk into the transmitter being tested. Listen in the headphones of the test receiver.

*Requirement:* Good quality, clearly understandable speech should be heard, with adequate audio volume.

# CHAPTER 4

# SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

## 81. Repacking for Shipment or Limited Storage

The exact procedure for repacking depends on the material available and the conditions under which the equipment is to be shipped or stored. Use the procedure outlined in *a* through *c* below whenever possible.

*a. Material Requirements.*

(1) The following materials are required for packaging Receiver-Transmitter RT–70(*)/GRC.

| Material | Quantity |
|---|---|
| Waterproof barrier material | 6.5 sq ft. |
| Tape, pressure-sensitive | 3.0 ft. |
| Fiberboard, corrugated single-faced | 10 sq ft. |
| Tape, gummed, paper | 6.0 ft. |
| Strapping steel | 8 ft. |
| * Wooden shipping box | 1 ea. |

* Dimensions of the wooden box are 15½ x 7½ x 9 inches. Packed weight of the box is 32½ pounds.

*b. Packaging.* The items of Receiver-Transmitter RT–70(*)/GRC are to be packaged as follows:

(1) *Receiver-transmitter.* Cushion the set on all surfaces with pads fabricated of single-faced, corrugated paper arranged to absorb the shock of impact in handling and transit. Secure the cushioning with gummed paper tape. Inclose each cushioned set within a wrap of single-faced, flexible, corrugated paper and secure with gummed paper tape.

(2) *Technical literature.* Inclose each technical literature within a close-fitting bag fabricated of waterproof barrier material. Seal the seams with water-resistant, pressure-sensitive tape.

*c. Packing.* Pack the receiver-transmitter in the wooden box previously constructed. Place the packaged technical literature within the box and fill any voids with pads made of flexible corrugated paper. Use metal strapping around the box when intertheater shipment is intended.

## 82. Demolition of Materiel to Prevent Enemy Use

The demolition procedures outlined in paragraph 83 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

## 83. Methods of Destruction

*a. Smash.* Smash capacitors, transformers, resistors, sockets, plugs, and other components; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or other heavy tools.

*b. Cut.* Cut wiring; use axes, handaxes, or machetes.

*c. Burn.* Burn manuals, records and forms, resistors, capacitors and transformers; use gasoline, kerosene, oil, flamethrowers, or incendiary grenades.

*d. Bend.* Bend chassis, panels, and covers.

*e. Explode.* If explosives are necessary, use grenades or TNT.

*f. Dispose.* Bury or scatter the destroyed parts, or throw them into streams.

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*NG:* State AG; units—same as Active Army.

*USAR:* None.

For explanation of abbreviations used, see SR 320–50–1.

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